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Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

MAY 1, 1988

UNITED WE STAND?

Will Sematech save the U.S. chip industry? PAGE 30

America's fastest-growing companies

PAGE 42

Top U.S. companies in Japan

PAGE 64

Charles Sporck, president of National Semiconductor

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

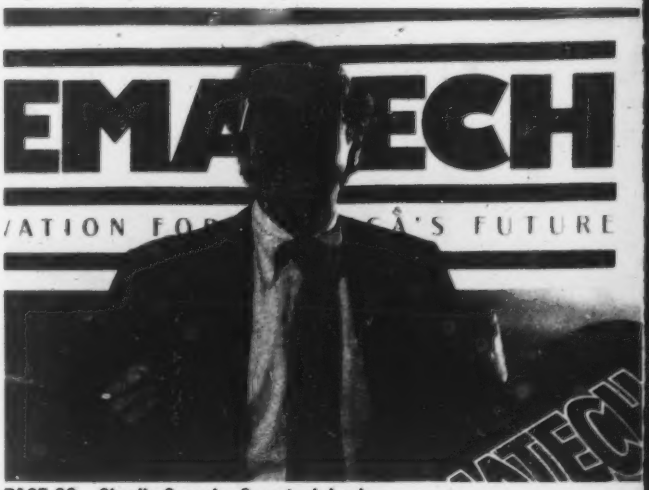
VOL. 14, NO. 9 MAY 1, 1988

COVER STORY/STRATEGIES

MANUFACTURING

30 Sematech: United we stand?

Throughout the past year, chairman Charles E. Sporck has been an active cheerleader for Sematech. He has aggressively lobbied lawmakers and vigorously recruited new members. But critics question whether the federally assisted consortium is really worth its annual $250 million budget. Will Sematech save the U.S. chip industry? Or will it become a massive boondoggle?



PAGE 30 Charlie Sporck—Sematech leader

BUSINESS TRENDS

MILITARY ELECTRONICS

16 Pols blast away at the Strategic Defense Initiative

Billion-dollar budget cuts are wreaking havoc on the president's plan to deploy space-based weaponry.

TECHNOLOGY INVESTMENT

18 IBM's European lab chief emphasizes applied R&D

Martin Reiser, who oversees IBM's Swiss research labs, welcomes licensing with other companies.

OFFICE AUTOMATION

20 Small fax machines are the new office gossips

The proliferation of small faxes should spell opportunity for U.S. parts suppliers. So why is Rockwell about the only one?

PASSIVE COMPONENTS

24 Specialty capacitors get vendors all charged up

They're no universal cure, but new application-specific capacitors promise vendors less competition and more profit.

COVER STORY/STRATEGIES

MANUFACTURING

32 Sematech: United we stand? The haves versus the have-nots

Despite intense recruiting by Sematech, small U.S. chip firms have thus far not joined. Why not?

34 Will technology leaks cripple Sematech?

Some Sematech members say they will gain a two-year technology lead over outsiders. Think again, say others.

36 Peace-maker or king-maker to IC equipment vendors?

Will Sematech help choose which production-gear makers thrive—and can it make them friendly with chip makers?

STRATEGIES

FINANCE

42 Sales-growth speedsters: Make way for a new generation

1987 was the year the workstation came of age, with Sun Microsystems topping the list of fastest growing companies.

- Fastest growing companies by industry segment
- Top 100 fastest growing companies

MANAGING RESOURCES

QUALITY CONTROL

57 Can a company spend too much on quality?

A joint poll by ELECTRONIC BUSINESS and Coopers & Lybrand suggests many firms may be penny-wise and quality-foolish.

Cover photo: Lane Erickson

ASIA BUSINESS

FINANCE

64 U.S. firms in Japan: Weak dollar is no panacea

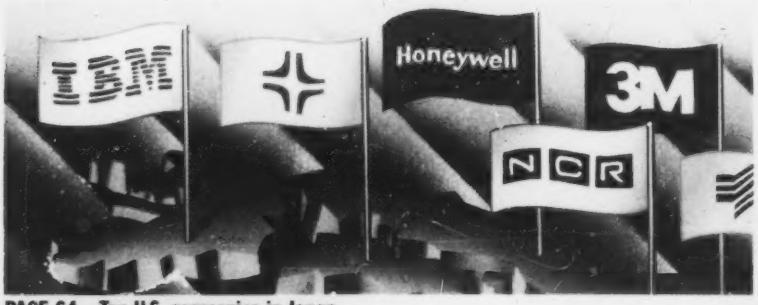
Even with a weak dollar, many U.S. companies stumbled in Japan last year. IBM Japan's earnings plunged 30%. Fuji Xerox's fell 21%.

- Top U.S. companies in Japan

SEMICONDUCTORS

70 Treaty travail: Hong Kong nervously awaits 1997

The outlook for the Hong Kong electronics industry looks promising, despite an exodus of people and capital.



PAGE 64 **Top U.S. companies in Japan**

PAGE 114 **GM's MAP master Kaminski**

PAGE 126 **Risky business—siting overseas plants**

PAGE 42 **The new generation of sales-growth speedsters**

PAGE 16 **Pols blast away at SDI**

Computer Business

SUPERCOMPUTERS

78 Cray designs its future without designer Steve Chen
The Y-MP will help Cray end this decade on a high note. But what will happen when Chen, backed by IBM, becomes a competitor?

SUPERMICROCOMPUTERS

86 Powerful PCs push supermicros up and out
Now faced with stiffer competition from 386-based PCs, Altos, Arix and Plexus are networking into new markets.

PERIPHERALS

93 Optical scanners: Patience has finally paid off
It took over a decade, but improved technology and marketing are finally pushing optical-scanner sales skyward.

Market Perspectives

MICROPROCESSORS

100 Picture a mega-market for processors that few can see
Embedded microprocessors, invisibly at work in everything from autos to robots, make up a half-billion dollar market that's cost-sensitive bar none.

Market Perspectives

PRINTED CIRCUITS

106 Flexible printed wiring reaches for consumer markets
Japan leads in flex for consumer uses; the U.S., in military. Both are growing but it's hard to bend high prices.

MANUFACTURING

114 Can MAP make it on the factory floor in 1988?
So far, the factory network's specs have scared off customers. As MAP 3.0 wares debut, 1988 may be different.

Sites & Facilities

INTERNATIONAL

126 The element of risk in siting overseas plants
There's more to locating that foreign facility than local tax breaks. Think about the political risks, too.

132 International directory of plant sites and facilities

144 Strategies for international manufacturing
An analysis of U.S. firms in Europe suggests alternative methods of boosting foreign sales.

Business Barometer

FORECASTS AND INDEXES

159 **Distribution**
DRAM sales sound alarm.
160 **Industrial production**
Components and instruments.
162 **Components**
Orders, shipments.
164 **Leading indicator for the U.S. electronics industry**

Departments

5 **Inside business**
Life in the fast lane
9 **Letters**
11 **Upstarts**
Emcore, Actel, and Omnirel
150 **Coming attractions**
153 **My view**
Reality therapy. Ride the bus
154 **Management calendar**
Advertiser index
166 **Viewpoint**
How many partners can you have?

COMPANIES IN THIS ISSUE

150 **An index of the 119 companies covered in this issue.**

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Life in the fast lane

Each year, ELECTRONIC BUSINESS tracks the fastest growing companies in the electronics industry. Compiled by senior editor Linda Stallmann, our financial analyst, the ranking tells me more about where technology is headed in this country than any other indicator I know.

Based on annual reports and other public documents, the article accompanying this year's list analyzes revenue figures for publicly held electronics companies by computing five-year compounded average growth. As this year's article — by associate editor Bruce Rayner — points out, CAE and workstation companies were clearly among the biggest gainers from 1982 to 1987. But, I suppose, that's not all that surprising, if you really think about it. After all, where technology goes, bucks will follow.

Heading some of the fastest growing companies are, from left: Daisy's Friedmann; Apollo's Vanderslice; Mentor's Bruggere; and Sun's McNealy

Not just Sematech semantics

We have no doubt whatsoever that most of our readers will have no trouble recognizing the unabashed Cheerleader for Competitiveness on our cover. The man with the megaphone is, indeed, none other than Charlie Sporck, the driving force behind both National Semiconductor and Sematech, the controversial industry consortium aimed at reviving America's semiconductor industry.

But, as the cover story by senior editor Alden Hayashi and associate editor Valerie Rice ably points out, the growing controversy over Sematech is not just a question of semantics. It's a "do or die" situation today in the roller-coaster microelectronics industry. And in this series of articles, Alden and Valerie take a long hard look at the political and economic implications of Sematech's very existence.

Check out our redesign

If you're a longtime subscriber to ELECTRONIC BUSINESS, you may have noticed that our art department has redesigned the magazine — starting with the cover and ending with editorial director Alberto Socolovsky's "Viewpoint" on the final page. The purpose of the new format is primarily to provide our readers with quicker and easier access to business information.

Our late publisher, J. Chat Kelly — who died Feb. 13 of lymphatic cancer — was the driving force behind the decision to give the magazine a more modern look. This issue and the entire redesign is dedicated to his memory.

AL FURST

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BPA ABP

Pols blast away at the Strategic Defense Initiative

Billion dollar budget cuts are wreaking havoc on the president's plan to deploy space-based weaponry

From its inception, President Reagan's Strategic Defense Initiative (SDI) captured defense contractors' attention. Excited about the prospect of a $5 billion to $6 billion a year market for ballistic missile defense research and development, firms raced to get a piece of the action. Now, five years later, contractors and Pentagon officials worry that "Star Wars" is losing steam.

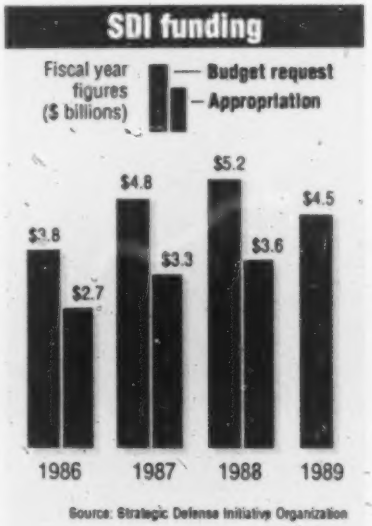
The president's fiscal 1989 budget requested only $4.5 billion in SDI funding for the year beginning Oct. 1, 1988 — $700,000 less than the amount sought by the Strategic Defense Initiative Organization (SDIO). The administration pared their SDI and other defense appropriations in its bid to present an uncontroversial election-year budget. Making matters worse for contractors, Congress is expected to further pare appropriations. For fiscal 1988, Congress limited SDI spending to $3.6 billion, about one-third less than the president's request of $5.2 billion. "When you take out that amount of money, a lot of programs are bound to get hurt," says Col. Garry A. Schnelzer, SDI acting deputy for technology.

As a result, cuts have been made across the board, although some programs fared better than others. Many contracts have been canceled, cut back or delayed. "The new budget will probably stretch out some of our programs," says A. Julian Scott, vice president of Harris Corp.'s Government Special Programs, the group responsible for coordinating Harris' SDI efforts. Harris has 35 SDI contracts valued at about $80 million.

SDI critics and proponents alike expect SDI funding to stabilize at about $4 billion a year for the near term. For the long term, SDI spending for research and development — and possible deployment — will be determined by future administrations. "There's no question that everybody agrees on the need for research, but deployment will be decided by the administration in power in the early 1990s," says Morry H. Thorsen, vice president of advanced systems for Martin Marietta Corp.'s Astronautics Group.

John Pike, an outspoken SDI critic at the Federation of American Scientists in Washington, agrees. "We clearly need to do research to stay ahead of the Russians," according to Pike. "The question is: Do you need to spend $4 billion?" Answering his own question, Pike continues: "Probably not." He suggests spending less than $3 billion on missile defense. Pike estimates that the U.S. defense industry is five years ahead in laser and rocket interceptors; five to 10 years ahead on sensors and 10 years ahead on battle management.

Because of budget cuts, it now looks like the goal of deploying a space weapons shield in the early 1990s will, at best, be postponed a few years; and, at worst, shelved forever. Furthermore, Reagan's goal of testing antimissile weapons in space has been put on the back burner, while SDI emphasizes more ground-based testing and laboratory work.

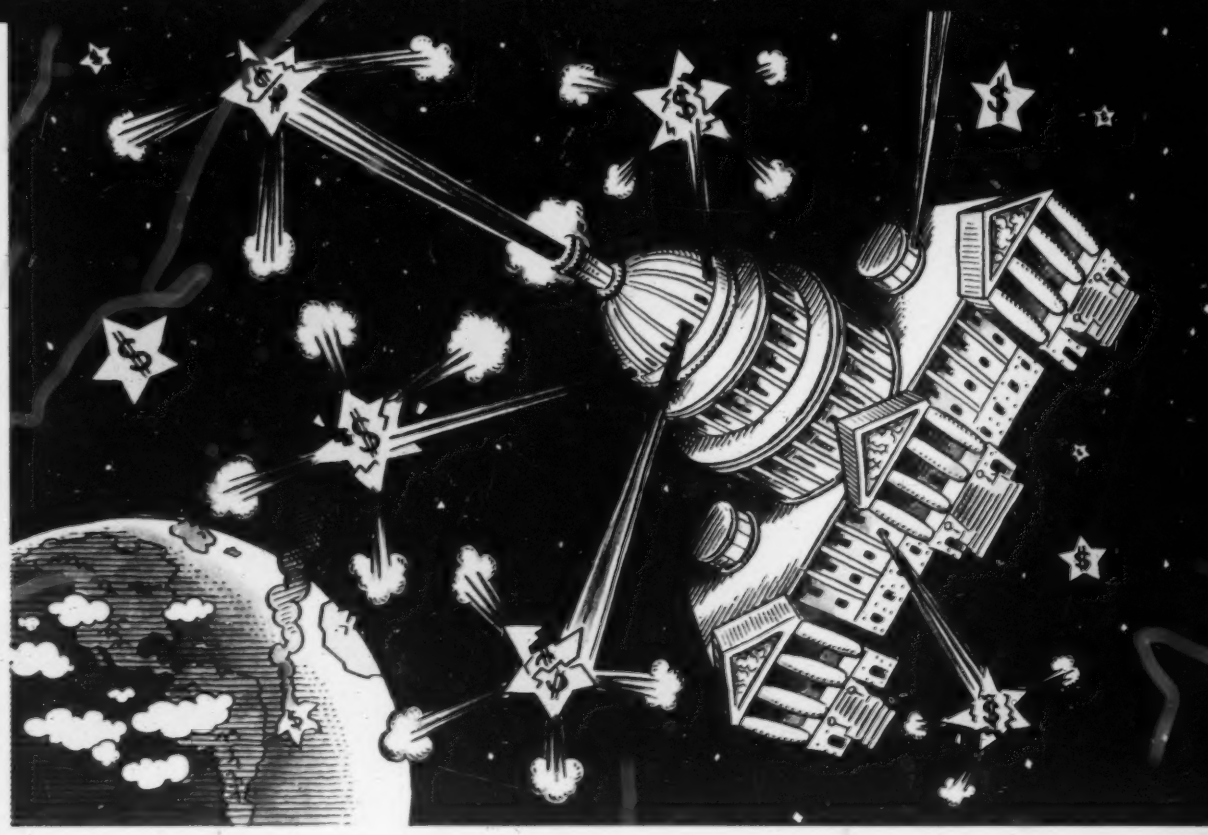


Earlier this year, for example, Martin Marietta's Information Communications Systems won a $508 million contract to test and evaluate a simulated missile defense system at a variety of test sites around the country. A week later, the Air Force canceled a $480.8 million contract with McDonnell Douglas Astronautics Co. to design, fabricate, integrate and test a space-based high-energy neutral particle beam device.

GaAs outlook

Especially hard hit by recent budget cuts are signal processing technology programs, including radiation-hardened gallium arsenide (GaAs), silicon and real-time signal processing efforts. The fiscal 1988 budget approved late last year appropriated $71.5 million for signal processing, almost half the amount Defense requested for the year and 22% below the previous year's expenditures. In 1989, further cuts are expected.

The gallium arsenide budget, cut in half from 1987 to 1988, will be slashed two-thirds in 1989 — down to $20 million from a requested $57 million in 1988. "We balanced gallium arsenide against silicon and gave priority to silicon," says Schnelzer. "We did, however, try to maintain as much as we could of gallium arsenide. These cuts significantly reduce the support activities in materials, characterization, advanced device development and a GaAs computer subsystem demonstration. Meanwhile, the microprocessor program — an analog-to-digital converter — as well as pilot production lines and some key efforts in computer-aided design of gate arrays and reliability continue, with some cutbacks. Certain follow-on efforts



Ron Barrett

in GaAs research will proceed when funds are made available.

Yields have risen dramatically at the Defense Department-sponsored pilot production lines at Rockwell International Corp.'s Seal Beach, Calif., facility and AT&T's Bell Laboratories. McDonnell Douglas, meanwhile, is also developing GaAs chips with funding from the government and other sources. "Our pilot plants are making 8I gate devices with yields of 30% to 40%," says Schnelzer. Our goal is yields above 40% and that's very achievable."

Silicon R&D expenditures, meanwhile, have been reduced about 25%. Budget cuts scaled back such efforts as the radiation-hardened VHSIC vector processor, wafer scale integration and silicon-on-insulator programs. "The efforts in radiation-hardened silicon-on-insulator have made excellent progress," says Schnelzer. "And several contracts have achieved extremely good results in radiation-hardened bulk silicon VHSIC."

Indeed, despite budget cuts, the Strategic Defense Initiative Organization is looking closely at very high-speed integrated circuit technology for supercomputers. "VHSIC chips provide the speed and efficiency that we'd like for space-based technology," says Schnelzer. Hughes, for example, is developing a five-wafer stack of chips for a three-dimensional computer. Such a computer, with stacks of wafers, "offers substantial speed improvement over standard two-dimensional computers," according to an SDI technical progress report from April 1987. "A 100- to 1,000-fold improvement can potentially be obtained through advanced electronics and packaging," the report continues. "A five-wafer stack was assembled with greater than 99% yield."

Especially hard hit by recent budget cuts are signal processing technology programs

Miniaturization is critical to SDI's success. R&D efforts are aimed "at putting a lot in very small packages," according to Schnelzer. "Memory is very important to us." SDI is building a base, ranging from 2K static random-access memories to 16K SRAMS and higher.

SDI officials contend that one of the key benefits of Star Wars R&D is the potential for commercial spin-offs. "Technology transfer is important for any federal program," says Col. James A. Ball, director of technology applications for the Strategic Defense Initiative Organization. "We must create the tools that make government sponsored data accessible to American industry." Toward this end, SDIO has started up the Technology Applications Information System, a computer-based database that includes summaries of more than 200 unclassifed SDI research programs. Available technologies range from adaptive electro-optical signal proccesors to Z-plane planer detector arrays. Further information can be obtained by calling 800-DLA-DLSC or 202-693-3008.

FDI officials contend that the program will help expand this country's technology base, arguing that NASA research over the past decade or more has spun off important technology to the commercial sector. Critics, however, counter that if there were indeed commercial payoffs, companies would already be working on the technology. Moreover, some opponents dispute the argument that NASA R&D really led to lucrative commercial spin-offs. "We didn't go to the moon to discover Tang," says Pike.

But contractors have more than Tang on their minds. With various other major defense contracts coming to an end, they need SDI business to survive and grow.

BETH KARLIN

Sales-growth speedsters: Make way for a new generation

1987 was the year the workstation came of age, with Sun Microsystems topping the list of fastest growing companies

BY BRUCE C.P. RAYNER AND BY LINDA STALLMANN

It should come as no surprise that Sun Microsystems Inc. is the top-growth electronics company for 1987. With a five-year compounded growth rate of 474%, the $537 million workstation company sets a new record in the ELECTRONIC BUSINESS survey of the 100 fastest growing companies, now in its fourth year. By most accounts, Sun is destined for the billion-dollar club by the end of 1988.

Part of the reason for Sun's stellar performance is the growth of the workstation market itself. Computer-aided engineering workstations hardly existed at the beginning of the decade, but by 1987, reports market research firm Dataquest Inc., total worldwide revenue for workstations had reached $17 billion. The other component of Sun's growth comes from the corporate commitment to industry standards and open systems: "Everybody wants them," says Joseph Roebuck, Sun's vice president for sales. This commitment has earned Sun a 33% market share in 1987, up from 20% in 1986, a gain that Roebuck characterizes as "phenomenal."

But Sun is not the only benefactor of the workstation boom: fifth-ranked Mentor Graphics Corp., maker of engineering design systems, posted record sales and profits in 1987; 12th-placed Apollo Computer Inc., one of Sun's main competitors, has had five-year compounded growth at just under 100%; and CAE vendor Daisy Systems Corp., 15th on the list, boosted sales for a five-year average of 85.7%, despite its recent slow growth and losses in both 1986 and 1987. Gerard Langeler, president of Mentor, acknowledges that demand for workstations has contributed to his company's success, but insists that software is also important. "There is no workstation market without the applications to run on them," he says.

Just because workstation makers are in a fast-paced industry does not mean they have a monopoly on growth. Software, personal computers, chips and peripherals all are represented in the top echelons of the ELECTRONIC BUSINESS growth list. In fact, when taken as an industry segment, software was the leading performer in 1987. Sales of software grew at a rate of 64.3%, while profits grew at 84.6%. Second-ranked Lotus Development Corp., maker of the 1-2-3 database program, beat the average by over five times, posting an average sales growth rate of 369%. Peripherals makers came second, with average sales growth of 47.4%.

"I think the No. 1 reason for growth," admits Q.T. Wiles, chairman of sixth-placed MiniScribe Corp., a $362 million maker of rigid disk drives, "is that we are in a fast-growing industry." Also important are good management — MiniScribe employs a divisionalized style as opposed to a functional management style — tight cost control and being market-, not technology-driven, he adds. MiniScribe was at the top of the list last year, posting 369.5% average growth.

Calling California home

One significant trend gleaned from this list is the fact that 41 of these companies call California home. The number has been slowly but steadily inching up over the years. The closest competitor is Massachusetts, with 14 resident companies. In the future,

Top 10 fastest growing companies

1987 rank	Company	Market	5-year sales growth	Fiscal 1987 sales ($ millions)
1	**Sun Microsystems**	Workstations	474.4%	$537.5
2	**Lotus Development**	PC software	369.2%	395.6
3	**AST Research**	Boards and PCs	249.5%	206.0
4	**Iomega**	Floppy disks	185.2%	89.4
5	**Mentor Graphics**	CAE systems	164.1%	221.8
6	**MiniScribe**	Rigid disks	135.1%	362.5
7	**Symbolics**	AI systems	125.0%	103.8
8	**Oracle**	Database software	121.3%	131.3
9	**LSI Logic**	Gate array chips	121.0%	262.1
10	**Wyse Technology**	Terminals and PCs	102.9%	260.0

Source: ELECTRONIC BUSINESS

Dorothy Ahle

Driven by design: Heading some of the fastest growing companies are, from left: Daisy's Norman Friedmann; Apollo's Thomas Vanderslice; Mentor's Thomas Bruggere; and Sun's Scott McNealy

look to Texas to spawn high-growth companies. *Inc. Magazine* recently ranked Austin, Texas, the fastest growing city in the United States, partly because it won the sweepstakes to woo the Sematech semiconductor industry consortium. Also, Houston has started a campaign to become the next aerospace capital of America, after Southern California.

As with most previous years, the common thread in the top-growth companies is youth. In the top 10 this year, the oldest entrant is eighth-ranked Oracle Corp., a database management software company formed a decade ago. All other companies were established in the 1980s.

In order to qualify for ELECTRONIC BUSINESS' top 100 fast-growth list, a company must have reported sales for the past six years, with 1987 sales reaching at least $80 million. Also, the company must be U.S.-based and publicly held, with at least 70% of its total sales in electronics.

The six-year sales figure criterion was the disqualifier for Compaq Computer Corp. Compaq, the second-largest business personal computer maker in the world, behind IBM, was formed in 1982 but did not start shipping product until January 1983. It broke a first-year sales record by pulling in $111 million and has not looked back since. In 1987 the company nearly doubled its 1986 revenue by selling $1.2 billion worth of computers.

Michael Swavely, Compaq's vice president for sales, puts the company's performance down to the fact that Compaq has always considered itself a large company, even as a start-up. "In our part of the industry, you have to be a large company to compete," Swavely says. For 1988, he expects the company to outpace the forecast industry growth rate of 20%.

While growth is by definition faster when the company is just starting out, there are 13 billion-dollar companies that make an appearance in the ELECTRONIC BUSINESS fastest growing 100: leading the pack is $2.7 billion Apple Computer Inc., at No. 40. Between heavy hitters Digital Equipment Corp. and Unisys Corp., it was a close call for 68th and 69th place. Both Digital and Unisys are players in the workstation market, with DEC producing its own boxes and Unisys reselling the Sun system.

Where's IBM?

One mega-company conspicuous by its absence is IBM. For the past few years, Big Blue has been steadily climbing from 88th place in 1985 to 76th place last year. But because of lagging sales growth last year, IBM's 1987 five-year growth rate fell to

9.5% for the year, down from its 1986 figure of 12%. But this slowing growth figure is deceptive. In total, IBM boosted sales by $2.96 billion last year, an enviable figure for any company that made the list.

The key to growth, say top per formers, is a combination of elements: being young means you are aggressive and that is essential; having a good distribution system means product gets to market faster; an ability to differentiate yourself from the pack technically helps in the battle for market share; a willingness to take some calculated — and some not so calculated — risks usually accelerates growth; and being in the right place at the right time always helps.

"Our growth is based on commonsense business tactics that keep the company going with a solid foundation," says Thomas Yuen, vice president for marketing and one of three founders of third-ranked AST Research Inc. Yuen has helped to guide AST from the add-in board business into a premier desktop computer systems house. Looking back on the transition period, Yuen says the biggest problem has been production capacity. "The capacity we initially forecast was way below what we can satisfy," he says.

Bernard Tse, chairman and chief executive of 10th-placed terminal maker Wyse Technology, says his strategy is no secret: "We picked a market that is enormous and tried to be very competitive." Tse claims both a cost advantage and a price advantage and "with a little bit of luck we have been able to grow very fast." But the company's luck may have limits. Seven-year-old Wyse is operating in a business that is actually shrinking, a worrisome phenomenon to a growth-oriented company. Dataquest estimates that the worldwide terminal market contracted to $3.5 billion last year, down from $3.9 billion in 1986. Still, Wyse grew its market share in 1987 from 14% to 17%, the only terminal maker to do so.

Two top-growth companies in less than robust health are Iomega Corp. and Symbolics Inc. Iomega, a maker of floppy disk drives, has reported a net loss of $36.7 million for calendar 1987 as a result of a decline in demand, substantial reduction in inventory level and slower than anticipated acceptance of the company's new 5.25 product. Symbolics, a manufacturer of symbolic processing systems for technical and artificial-intelligence workstations, reported a net loss of $25.5 million in fiscal 1987, ending June 30, and losses of $19.9 million for the first half of fiscal 1988. The company is in a restructuring mode to pare down operations.

1987's fastest-growing companies by segment

	5-year sales growth	5-year profit growth	1987 rank
Software			
Lotus Development	369.2%	NM	2
Oracle	121.3%	124.7%	8
Ashton-Tate	71.3%	109.4%	17
Microsoft	69.8%	82.9%	18
Ultimate	42.1%	36.6%	34
Cullinet Software	28.8%	NM	45
Weighted average	**64.3%**	**84.6%**	
Peripherals			
Iomega	185.2%	NM	4
MiniScribe	135.1%	NM	6
Wyse Technology	102.9%	NM	10
Seagate Technology	88.3%	82.3%	14
Archive	69.7%	NM	19
QMS	67.4%	38.5%	22
Quantum	54.6%	116.3%	25
Micropolis	54.3%	218.6%	26
Lee Data	53.0%	34.6%	27
Intelligent Systems	46.0%	NA	30
Emulex	44.9%	10.8%	31
Xidex	42.5%	NM	33
Priam	34.0%	NM	41
Peripherals (continued)			
Cipher Data Products	25.1%	12.7%	53
Applied Magnetics	18.0%	9.7%	74
Printronix	13.8%	NM	90
Key Tronic	12.0%	-34.2%	98
Weighted average	**47.4%**	**30.2%**	
Computer-based systems			
Mentor Graphics	164.1%	NM	5
Daisy Systems	85.7%	NM	15
Mark IV Industries	67.6%	72.3%	21
Intergraph	32.7%	40.0%	42
Ask Computer Systems	31.6%	24.3%	44
Data Card	26.9%	-15.2%	51
ISC Systems	22.1%	-4.2%	57
Evans & Sutherland	20.1%	8.5%	61
Recognition Equipment	18.7%	NM	72
Coherent	14.6%	NM	82
Measurex	14.0%	NM	86
Computer Consoles	13.4%	5.3%	93
Weighted average	**27.9%**	**42.7%**	

(Continued)

NA = Not available
NM = Not meaningful, company had a loss in one of the base years

1987's fastest-growing companies by segment

Computers

	5-year sales growth	5-year profit growth	1987 rank
Sun Microsystems	474.4%	NM	1
Symbolics	125.0%	NM	7
Stratus Computer	101.9%	NM	11
Apollo Computer	98.2%	134.3%	12
Kaypro	80.9%	NM	16
SCI Systems	43.8%	31.2%	32
Cray Research	37.2%	50.6%	37
Apple Computer	35.5%	28.8%	40
Telex	32.3%	45.8%	43
Tandem Computers	27.1%	28.7%	49
Amdahl	26.6%	96.3%	52
Altos Computer Systems	24.7%	11.1%	54
Wang Laboratories	19.6%	NM	64
DEC	19.3%	22.2%	68
Unisys	18.9%	33.4%	69
Prime Computer	17.1%	7.6%	77
Tandy	13.5%	1.6%	91
Weighted average	**21.6%**	**20.6%**	

Semiconductors

	5-year sales growth	5-year profit growth	1987 rank
LSI Logic	121.0%	NM	9
Micron Technology	94.4%	NM	13
Western Digital	69.3%	NM	20
VLSI Technology	52.0%	NM	28
Silicon Systems	38.5%	14.3%	35
Burr-Brown	19.8%	16.3%	62
Advanced Micro Devices	19.5%	NM	65
Analog Devices	16.3%	13.6%	79
Intel	16.2%	52.5%	80
Siliconix	15.3%	40.2%	81
Weighted average	**22.4%**	**43.2%**	

Distributors

	5-year sales growth	5-year profit growth	1987 rank
Anthem Electronics	38.5%	27.0%	36
Marshall Industries	19.4%	NM	67
Pioneer-Standard Electronics	17.5%	-4.4%	76
Wyle Laboratories	13.4%	NM	92
Weighted average	**18.9%**	**144.9%**	

[1] Acquired by Unisys Corp. Jan 22, 1988
NA = Not available
NM = Not meaningful, company had a loss in one of the base years

Communications

	5-year sales growth	5-year profit growth	1987 rank
Digital Communications Assoc.	66.5%	107.0%	23
Regency Electronics	49.5%	36.8%	29
Timeplex[1]	35.5%	NA	38
DSC Communications	35.5%	16.7%	39
Micom Systems	27.8%	9.0%	47
Bolt Beranek and Newman	27.6%	NM	48
General DataComm Industries	27.0%	NM	50
Dynatech	23.7%	30.3%	55
Cincinnati Microwave	22.9%	17.6%	56
ADC Telecommunications	21.8%	26.9%	58
Avantek	20.6%	4.3%	60
Motorola	12.1%	12.6%	97
Weighted average	**15.8%**	**15.1%**	

Defense

	5-year sales growth	5-year profit growth	1987 rank
Electrospace Systems	28.2%	18.3%	46
Loral	19.6%	17.2%	63
Logicon	18.9%	14.1%	70
AEL Industries	18.8%	52.8%	71
Varo	13.9%	8.5%	88
E-Systems	11.8%	8.2%	100
Weighted average	**15.6%**	**12.9%**	

Capital equipment

	5-year sales growth	5-year profit growth	1987 rank
LTX	20.7%	NM	59
Teradyne	16.5%	NM	78
Gerber Scientific	14.2%	44.0%	84
Hewlett-Packard	14.1%	11.0%	85
Applied Materials	13.9%	NM	87
Nicolet Instruments	13.3%	3.0%	94
Weighted average	**14.2%**	**10.6%**	

Components (other than semiconductors)

	5-year sales growth	5-year profit growth	1987 rank
Molex	18.5%	15.9%	73
AVX	17.7%	38.8%	75
AMP	13.3%	16.0%	95
Cherry	12.3%	-8.5%	96
International Rectifier	11.9%	NM	99
Weighted average	**14.0%**	**15.7%**	

(Continued)

1987's fastest-growing companies

1987 rank	Company	5-year sales growth	Fiscal 1987 sales ($ millions)	Fiscal 1987 profits ($ millions)	Fiscal year ended	Location
1	Sun Microsystems	474.4%	537.5	36.3	6/87	Mountain View, Calif.
2	Lotus Development	369.2%	395.6	72.0	12/87	Cambridge, Mass.
3	AST Research	249.5%	206.0	13.0	6/87	Irvine, Calif.
4	Iomega	185.2%	89.4	-36.7	12/87	Roy, Utah
5	Mentor Graphics	164.1%	221.8	20.3	12/87	Beaverton, Ore.
6	MiniScribe	135.1%	362.5	31.1	12/87	Longmont, Colo.
7	Symbolics	125.0%	103.8	-25.5	6/87	Cambridge, Mass.
8	Oracle	121.3%	131.3	15.6	3/87	Belmont, Calif.
9	LSI Logic	121.0%	262.1	10.7	12/87	Milpitas, Calif.
10	Wyse Technology	102.9%	260.0	18.1	3/87	San Jose, Calif.
11	Stratus Computer	101.9%	184.2	19.4	12/87	Marlboro, Mass.
12	Apollo Computer	98.2%	553.7	21.7	12/87	Chelmsford, Mass.
13	Micron Technology	94.4%	91.2	-22.9	8/87	Boise, Idaho
14	Seagate Technology	88.3%	958.1	139.7	6/87	Scotts Valley, Calif.
15	Daisy Systems	85.7%	100.9	-16.3	9/87	Mountain View, Calif.
16	Kaypro	80.9%	105.6	-9.6	8/87	Solana Beach, Calif.
17	Ashton-Tate	71.3%	267.3	43.1	1/88	Torrance, Calif.
18	Microsoft	69.8%	345.9	71.9	6/87	Redmond, Wash.
19	Archive	69.7%	88.8	6.1	9/87	Costa Mesa, Calif.
20	Western Digital	69.3%	462.5	42.8	6/87	Irvine, Calif.
21	Mark IV Industries	67.6%	291.5	10.2	2/87	West Amherst, N.Y.
22	QMS	67.4%	119.4	8.7	9/87	Mobile, Ala.
23	Digital Communications	66.5%	181.4	27.0	6/87	Alpharetta, Ga.
24	Emerson Radio	56.0%	810.1	26.6	3/87	North Bergen, N.J.
25	Quantum	54.6%	120.8	8.8	3/87	Milpitas, Calif.
26	Micropolis	54.3%	288.3	27.2	12/87	Chatsworth, Calif.
27	Lee Data	53.0%	114.5	5.4	3/87	Minneapolis, Minn.
28	VLSI Technology	52.0%	172.0	8.1	12/87	San Jose, Calif.
29	Regency Electronics	49.5%	495.3	24.3	6/87	Indianapolis, Ind.
30	Intelligent Systems	46.0%	163.0	NA	12/87	Norcross, Ga.
31	Emulex	44.9%	103.8	3.5	6/87	Costa Mesa, Calif.
32	SCI Systems	43.8%	552.9	16.0	6/87	Huntsville, Ala.
33	Xidex	42.5%	572.8	-44.5	6/87	Mountain View, Calif.
34	Ultimate	42.1%	172.9	13.8	4/87	East Hanover, N.J.
35	Silicon Systems	38.5%	81.8	2.8	9/87	Tustin, Calif.
36	Anthem Electronics	38.5%	196.9	5.0	12/87	San Jose, Calif.
37	Cray Research	37.2%	687.3	147.1	12/87	Minneapolis, Minn.
38	Timeplex	35.5%	147.2	NA	6/87	Woodcliff Lake, N.J.
39	DSC Communications	35.5%	312.4	14.6	12/87	Plano, Texas
40	Apple Computer	35.5%	2,661.1	217.5	9/87	Cupertino, Calif.
41	Priam	34.0%	129.6	-41.3	6/87	San Jose, Calif.
42	Intergraph	32.7%	641.1	69.9	12/87	Huntsville, Ala.
43	Telex	32.3%	840.7	77.9	3/87	Tulsa, Oklahoma
44	Ask Computer Systems	31.6%	98.3	8.0	6/87	Los Altos, Calif.
45	Cullinet Software	28.8%	174.9	-27.6	4/87	Westwood, Mass.
46	Electrospace Systems	28.2%	190.7	10.1	3/87	Richardson, Texas
47	Micom Systems	27.8%	196.7	12.2	3/87	Simi Valley, Calif.
48	Bolt Beranek and Newman	27.6%	233.8	-8.0	6/87	Cambridge, Mass.
49	Tandem Computers	27.1%	1,035.5	105.6	9/87	Cupertino, Calif.
50	General DataComm Industries	27.0%	200.6	0.8	9/87	Middlebury, Conn.

[1] Estimate by INP 2/22
[2] Acquired by Unisys Corp. Jan. 22, 1988
NA = Not available

(continued)

1987's fastest-growing companies

1987 rank	Company	5-year sales growth	Fiscal 1987 sales ($ millions)	Fiscal 1987 profits ($ millions)	Fiscal year ended	Location
51	**Data Card**	26.9%	176.1	1.6	3/87	Minneapolis, Minn.
52	**Amdahl**	26.6%	1,505.2	142.0	12/87	Sunnyvale, Calif.
53	**Cipher Data Products**	25.1%	178.2	4.3	6/87	San Diego, Calif.
54	**Altos Computer Systems**	24.7%	153.9	9.7	6/87	San Jose, Calif.
55	**Dynatech**	23.7%	304.7	23.2	3/87	Burlington, Mass.
56	**Cincinnati Microwave**	22.9%	80.9	12.3	12/87	Cincinnati, Ohio
57	**ISC Systems**	22.1%	168.5	6.5	6/87	Spokane, Wash.
58	**ADC Telecommunications**	21.8%	166.9	15.3	10/87	Bloomington, Ind.
59	**LTX**	20.7%	120.6	-6.7	7/87	Westwood, Mass.
60	**Avantek**	20.6%	213.7	11.6	12/87	Santa Clara, Calif.
61	**Evans & Sutherland**	20.1%	134.4	14.7	12/87	Salt Lake City, Utah
62	**Burr-Brown**	19.8%	140.5	4.3	12/87	Tucson, Ariz.
63	**Loral**	19.6%	690.0	57.5	3/87	New York, N.Y.
64	**Wang Laboratories**	19.6%	2,836.7	-70.7	6/87	Lowell, Mass.
65	**Advanced Micro Devices**	19.5%	997.1	-48.1	12/87	Sunnyvale, Calif.
66	**Diasonics**	19.5%	267.6	15.2	12/87	South San Francisco, Calif.
67	**Marshall Industries**	19.4%	286.6	5.1	5/87	El Monte, Calif.
68	**DEC**	19.3%	9,389.4	1,137.4	6/87	Maynard, Mass.
69	**Unisys**	18.9%	9,712.9	578.0	12/87	Detroit, Mich.
70	**Logicon**	18.9%	204.8	6.1	3/87	Torrance, Calif.
71	**AEL Industries**	18.8%	108.4	3.3	2/87	Landsdale, Pa.
72	**Recognition Equipment**	18.7%	264.7	11.2	10/87	Dallas, Texas
73	**Molex**	18.5%	386.8	43.4	6/87	Lisle, Ill.
74	**Applied Magnetics**	18.0%	211.9	14.2	9/87	Goleta, Calif.
75	**AVX**	17.7%	271.9	15.8	12/87	Great Neck, N.Y.
76	**Pioneer-Standard Electronics**	17.5%	212.2	1.8	3/87	Cleveland, Ohio
77	**Prime Computer**	17.1%	960.9	64.8	12/87	Natick, Mass.
78	**Teradyne**	16.5%	377.7	-21.1	12/87	Boston, Mass.
79	**Analog Devices**	16.3%	370.4	18.7	10/87	Norwood, Mass.
80	**Intel**	16.2%	1,907.1	248.1	12/87	Santa Clara, Calif.
81	**Siliconix**	15.3%	122.5	3.9	12/87	Santa Clara, Calif.
82	**Coherent**	14.6%	159.0	-1.1	9/87	Palo Alto, Calif.
83	**Hadco**	14.6%	124.3	2.6	10/87	Salem, N.H.
84	**Gerber Scientific**	14.2%	223.9	21.1	4/87	South Windsor, Conn.
85	**Hewlett-Packard**	14.1%	8,090.0	644.0	10/87	Palo Alto, Calif.
86	**Measurex**	14.0%	227.4	26.8	11/87	Cupertino, Calif.
87	**Applied Materials**	13.9%	174.4	0.3	10/87	Santa Clara, Calif.
88	**Varo**	13.9%	95.3	3.5	4/87	Garland, Texas
89	**Zenith Electronics**	13.8%	2,362.7	-19.1	12/87	Glenview, Ill.
90	**Printronix**	13.8%	123.7	-4.9	3/87	Irvine, Calif.
91	**Tandy**	13.5%	3,452.2	242.3	6/87	Fort Worth, Texas
92	**Wyle Laboratories**	13.4%	368.0	5.8	1/88	El Segundo, Calif.
93	**Computer Consoles**	13.4%	148.4	9.6	12/87	Waltham, Mass.
94	**Nicolet Instruments**	13.3%	121.6	5.4	3/87	Madison, Wis.
95	**AMP**	13.3%	2,318.0	250.0	12/87	Harrisburg, Pa.
96	**Cherry**	12.3%	160.6	2.7	2/87	Waukegan, Ill.
97	**Motorola**	12.1%	6,700.0	308.0	12/87	Schaumburg, Ill.
98	**Key Tronic**	12.0%	107.6	0.5	6/87	Spokane, Wash.
99	**International Rectifier**	11.9%	151.8	-17.2	6/87	El Segundo, Calif.
100	**E-Systems**	11.8%	1,227.2	60.4	12/87	Dallas, Texas

Source: ELECTRONIC BUSINESS

Can a company spend too much on quality?

A joint poll by ELECTRONIC BUSINESS and Coopers & Lybrand suggests many firms may be penny-wise and quality-foolish

BY IRWIN KRAUSE
AND CHERYL R. SUCHORS

Most electronics companies in the United States are spending too much to make quality products. They are quality-concerned, but not yet quality-wise.

High quality at low cost is an area in which U.S. manufacturers in the automotive, small appliance and semiconductor industries, to name a few, have taken a drubbing from the Japanese in the past decade. As a result, quality has become a foremost issue for U.S. electronics companies.

We found in a recent survey of 144 electronics companies, jointly conducted by ELECTRONIC BUSINESS magazine and Coopers & Lybrand, that in nearly half of the companies, the head of quality control (QC) reports directly to the president or chief executive officer.

Unfortunately, despite this high-level situation, most of the companies surveyed still take an old-line approach to QC. Most companies in the survey have documented test and inspection procedures. Many have also developed a QC organization, have written QC policies and manuals, and currently use sophisticated test and measurement equipment. About 81% also use sampling plans; 75% perform 100% inspection.

These are the standard components of a traditional QC program — one that is chiefly based on a group of QC personnel finding the flaws in everyone else's output. The QC organization acts as the official guardian of quality; no one else is consistently held responsible for it.

Of course, if this were the entire story, we would simply urge companies to review their policies to catch up with the times. We'd advise them to consider the progressive approach to quality — what is being increasingly referred to as "total quality control." This approach implies that everyone who plays a part in design and development, production, sales or service of a product also bears responsibility for the quality of that product. Because everyone is accountable for the quality of his or her own output, statistical methods of quality control are all that's required. These methods emphasize doing things right the first time, rather than relying upon later inspection to sort the bad from the good.

But, our survey results show most electronics companies are well aware of some of the latest techniques in total quality control. Paradoxically, they are implementing them right alongside the traditional techniques they were designed to replace.

We found, for example, that as many as 58% of those surveyed regularly employed statistical quality control methods; and 49% regularly utilized statistical process control techniques. But the redundancy of performing 100% inspection *and* using statistical techniques spells an unnecessarily high cost for quality.

A key tenet of the sound total quality control strategy is the notion of eliminating steps in the production process which add no value. We contend that all the companies which reported using 100% inspection methods — three-quarters of the participants — also have an immediate opportunity for large cost savings by eliminating this procedure. If a good vendor assurance program is instituted, and each person controls the quality of his or her output, inspecting each and every product after each critical step of production is wildly redundant. Building quality into a product adds value; checking to see if it's there adds only cost.

In our view, U.S. electronics firms,

Techniques companies use to assure quality

Annual revenue of companies ($ millions)

	Under $20	$20 to $50	$50 to $250	$250 to $500	$500 to $1 billion	Over $1 billion	All companies
Sampling plans	75%	94%	100%	88%	100%	100%	81%
100% inspection	72%	89%	90%	75%	80%	78%	75%
Statistical QA	51%	72%	70%	75%	80%	72%	58%
Statistical process control	40%	56%	50%	50%	60%	83%	49%

Survey is based on a questionnaire mailed to 1,750 managers of U.S. electronics firms selected at random from ELECTRONIC BUSINESS magazine's circulation. In all, executives from 144 separate firms responded for a response rate of 8.2%.

Source: ELECTRONIC BUSINESS, Coopers & Lybrand

while concerned enough about quality to implement new techniques, don't believe in the techniques enough to forego their traditional ways. From their responses, we conclude that most companies have already adopted some tactics of a cost effective total quality control strategy, but not the underlying philosophy which makes it cost effective. And they are paying the price for it, both in terms of artificially high costs to produce their products, and in market share lost to competitors who have implemented the techniques of total quality control.

How much does QC cost?

In our experience, most companies simply don't know how much their efforts to control quality cost. We believe the same is true for many of the survey participants, and it's a serious problem. If a company doesn't know what its true cost of quality is, it cannot have a cost effective total quality control strategy. Unknown costs can't be questioned, controlled or reduced. Profits are lower than they should be, as a result.

Several of the questions in our survey asking participants about the cost of quality in their organizations went largely unanswered. Of course, respondents could have been concerned about divulging confidential information. However, this seems unlikely as a primary motivation because close to two-thirds of the respondents estimated the cost of quality as a percentage of company revenue in 1986 and 1987. An additional 12% acknowledged they just didn't know those costs.

Even more telling is the fact that companies typically didn't include the full gamut of attendant costs in their estimates of quality cost. Engineering design changes, vendor certification, software "bugs," salaries of quality managers and supervisors, and depreciation of capital equipment for QC — while not obvious total quality control costs — nonetheless contribute to the cost of producing quality goods. Only a small percentage of the survey participants included these areas when determining their annual cost of QC.

United States versus Japan

Adding up the true cost of their current level of quality would shock many companies, especially if they both perform redundant quality operations and ignore critical areas such as vendor and software quality. A substantial percentage of the companies surveyed, 38%, had no vendor QC system. They risked the quality of their own products, or at least increased their cost of goods sold, by trusting that their vendors had functioning quality programs. A growing portion of the value-added of electronics products also derives from associated software. Only 43% utilized a software QC program. While some of the survey participants might not develop any product-associated software, none of the industry sectors rated highly in this component of total quality control.

Of those companies that were able to estimate the total cost of QC, most spend under 15% of sales to control quality, but a few spend as much as 15%. In contrast, the average Japanese company boasts a total quality control program that costs only 5% to 10% of sales. Consistently adopting the progressive techniques of total QC — and moving away from the traditional approach — would puncture the inflated quality costs American companies typically experience. Cutting quality costs dramatically can usually be accomplished with no incremental out-of-pocket dollars or added resources.

World class competitiveness requires implementation of a total quality control strategy in which workers have been given the training and the tools to control their processes. Management must provide the resources to establish process capability; non-value-added activities must be eliminated; and the "quality health" of the business must constantly be measured in terms of quality cost. Market share belongs to the leaders in total quality control.

Irwin Krause is the partner-in-charge of Coopers & Lybrand's new Center for Manufacturing Technology and past national director of Computer Integrated Manufacturing at Coopers & Lybrand

Cheryl Suchors is the director of the National High Technology Industries Group at Coopers & Lybrand

Top cost elements of quality assurance

Percentage of companies which include the element in figuring their annual cost of quality assurance

Inspectors	65%
Rework	64%
Scrap	59%
Quality engineers	54%
Quality managers and supervisors	49%
Warranty costs	47%
Vendor certification	37%
Engineering design changes	32%
Depreciation of quality assurance equipment	31%
Process control	31%

Source: ELECTRONIC BUSINESS, Coopers & Lybrand

Components of quality assurance programs

Components of QA program	Annual revenue of companies ($ millions) Under $20	$20 to $99	Over $1 billion	All companies
Documented inspection/ test procedures	82%	94%	100%	88%
QA organization	61%	100%	94%	77%
Written management - policy for QA	63%	88%	78%	76%
Accurate, up-to-date measurement and test equipment	56%	94%	89%	74%
QA/QC manual	57%	82%	72%	70%
Easily accessible quality records	57%	71%	72%	65%
Vendor QA program	48%	65%	78%	62%
Philosophy that each inspects own work	57%	77%	83%	62%
QC procedure for product software	24%	41%	67%	43%

Source: ELECTRONIC BUSINESS, Coopers & Lybrand

U.S. firms in Japan: Weak dollar is no panacea

Even with the weak dollar, many U.S. companies stumbled in Japan last year. IBM Japan's earning plunged 30%. Fuji Xerox's fell 21%

BY PAULA DOE

The 10 leading U.S.-owned electronics companies in Japan reported sales of over $14 billion last year, up 23% from 1986. Nearly half of the increase came simply from more favorable exchange rates, but sales in yen were still up 14% for the year. That's a little better than the Japanese industrial electronics market overall, which grew by 10% for the fiscal year ended March 1987, according to the Electronic Industries Association of Japan.

Some major U.S. companies sharpened their strategies and took advantage of the cheap dollar to make impressive gains. Fuji Xerox Company Ltd. increased its yen-based sales by 31%. Yamatake-Honeywell Company Ltd. similarly achieved 30% growth. And Nihon Digital Equipment Corp. made some real money. The company's sales were up a modest 6%, but its pretax earnings increased by more than five times, climbing to $98 million, or a very fat 24% of sales.

But overall, U.S. electronics companies have yet to reap big gains from the 40% slide in the dollar against the yen over the past two years. Total yen sales for the top 10 declined 7% in 1986, and climbed back in 1987 to only 6% over their 1985 level. The 40% change in relative costs isn't bringing many companies fat profits either — half of the companies saw earnings decline in 1987, paced by a 30% drop at IBM Japan Ltd.

ELECTRONIC BUSINESS tracks the sales and earnings of companies in Japan that are at least 25% owned by U.S. electronics firms. We get figures directly from those companies that will release them. For the many companies that will not, we get data from the Japanese tax authorities, which is published in a number of Japanese language sources. The market research firm Dataquest in San Jose, supplies figures for U.S. semiconductor companies' sales in Japan. We don't try to track U.S. firms that sell through agents in Japan.

Changes at IBM Japan

IBM Japan recovered from a dismal 1986, when it saw its first-ever decline in revenue, to increase sales by 15% in 1987, becoming the first U.S. company to reach the ¥1 trillion sales (roughly $7 billion) mark. However, IBM paid for its sales gains with a 30% drop in pretax earnings. And it embarked on a new and uncharacteristic strategy of working closely with a host of Japanese companies as it tried to orchestrate a recovery and reach its ambitious goal of doubling sales by 1990.

IBM Japan started selling other companies' equipment in its systems, and allowing others to sell its equip-

Marty Braun

ment. It agreed to supply Ricoh Company Ltd. with IBM personal computers to sell under the Ricoh brand name. (Ricoh had long sold NEC Corp. PCs.) IBM Japan also invested in a number of regional software houses and systems engineering firms, and is reportedly sending key technical people to work with them. Company officials are escorting executives from Japanese computer companies on tours of IBM's research laboratories and factories in the United States, leading to speculation of cooperation with Mitsubishi Electric Corp., Oki Electric Industry Co. and Toshiba Corp.

IBM is not the only U.S. computer company active in Japan. Nihon DEC, the Japanese subsidiary of Digital Equipment Corp., is gaining share in Japan's medium-sized computer market. The company sold $169 million worth of midsized hardware in the fiscal year ended March 1987, for a 6.5% share of the market and a position as the No. 6 supplier, according to International Data Corp. (IDC) in Framingham, Mass. While sales of most suppliers were flat, and while IBM Japan and Fujitsu Ltd. saw 10% to 11% declines, DEC gained 8%.

"NEC and Nihon DEC are the big winners in the Japanese medium-scale market," notes Donald Bellomy, senior consultant at IDC. "DEC moved successfully into the financial community for the first time, with sales to Sumitomo Bank and Nomura Securities." In fact, Nihon DEC is so enthusiastic about the Japanese financial market that it reportedly has three salesmen in New York charged with selling to the U.S. offices of Japanese institutions.

The Japanese subsidiary of DEC aims to increase dramatically its revenue from the business sector, from 20% of total sales today to 50% in the future. To churn out the necessary business applications software, Nihon DEC gave development machines to some 150 to 200 software companies, and plans to double its software staff of 500 by 1990.

The rising star of the Japanese small computer market is NCR Japan. Even though its overall sales decreased last year, the company saw a 25% growth in its sales of small machines. The 25% increase by far outpaced the market's growth of 6%. NCR sales of $62 million gave the company about 1.5% of the $4.2 billion market, according to IDC. Nihon DEC owns about 1.9% of the market, IBM Japan about 7%. □

Top U.S. electronics companies in Japan

By sales	1987 sales ($ millions)	Percentage change (in yen)	Fiscal year ended
IBM Japan	$7,014	15%	12/87
Fuji Xerox	2,968	31%	10/87
Nippon Univac	1,100 [1]	6%	12/87
Yamatake-Honeywell	795	30%	9/87
Sumitomo 3M	783	22%	10/87
NCR Japan	593	-16%	11/87
Burroughs Japan	500 [1]	9%	12/87
Yokogawa-Hewlett-Packard	500	-22%	10/87
Nihon DEC	404	6%	6/87
Texas Instruments	396 [2]	0%	12/87

All 1987 yen figures were converted to dollars at the 1987 average rate of ¥144 = $1
[1] Company estimate
[2] Estimate from Dataquest Inc.

Source: ELECTRONIC BUSINESS

By income	1987 taxable income[1] ($ millions)	Percentage change (in yen)	Taxable year ended
IBM Japan	$653	-30%	3/87
Fuji Xerox	151	-21%	3/87
NCR Japan	108	-1%	3/87
Nihon DEC	98	437%	3/87
IBM Japan Sales[2]	74	72%	3/87
Sumitomo 3M	51	85%	3/87
AMP (Japan)	49	11%	3/87
Yokogawa-Hewlett-Packard	49	-13%	3/87
Nippon Univac	46	30%	3/87
Yamatake-Honeywell	40	-9%	3/87

[1] Some figures may have been reduced by losses carried forward from previous years. An exchange rate of ¥187 = $1 was used.
[2] IBM Japan Sales is considered a separate subsidiary for reporting purposes by the Japanese government. IBM Japan Sales is IBM Japan's export arm.

Source: Taxable income reported to the Japanese government, compiled by Tokuan Data Bank and published in Toyo Keizai's annual ranking of Japan's 20,000 most profitable companies. No figures are available for companies that sold through an agent and are not independently incorporated in Japan

Powerful PCs push supermicros up and out

Now faced with stiffer competition from 386-based PCs, Altos, Arix and Plexus are networking into new markets

BY JAN MURPHY

Small companies offering Unix multiuser machines to the business community are getting some real competition as they work to hold onto their share of the supermicrocomputer market.

When they first appeared, the supermicros, affectionately called "hot boxes," were powerful enough to support several users at a fraction of the cost of a traditional mainframe or supermini. But now that personal computers sporting Intel Corp.'s 32-bit 80386 chip and Motorola Inc.'s 32-bit 68020 processors have reached the market, and AT&T's Unix operating system is gaining popularity, makers of Unix supermicros are facing a throng of competitors. Chief among those original hot-box vendors are Altos Computer Systems, Arix Corp. and Plexus Computers Inc., all of San Jose.

Though decidedly crowded, the supermicro Unix multiuser market is still healthy enough to support a range of vendors.

Kate Comiskey, program manager for Unix research at International Data Corp., a Framingham, Mass., market research firm, says that the 1987 worldwide shipments of Unix multiuser systems generated about $5.7 billion in sales. The total market of Unix single and multiuser systems is expected to show a 32% compound annual growth rate over the five-year period between 1986 and 1991.

Still, survival of smaller companies is an issue. Tim Bajarin, executive vice president of San Jose market research firm Creative Strategies, framed the issue as a question: "With PCs becoming more powerful and superminis becoming cheaper, what do companies like Altos need to do to survive?"

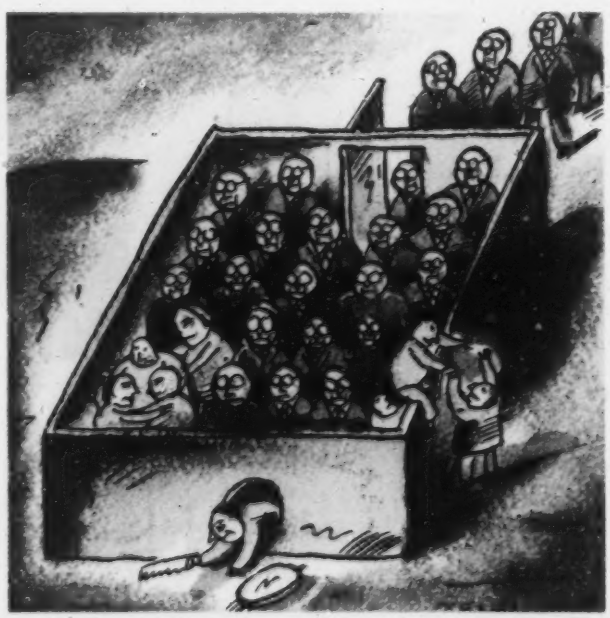
Psst! "Consolidate"

Some analysts whisper an encouraging word to these small companies, and the word is "consolidate." For Altos, consolidating means actively looking for third-party contracts with original equipment manufacturers and value-added resellers.

Altos' newest systems are part of its 386 series, which uses the Intel 80386 processor. The 1000 model costs from $7,500 to $15,000 and supports four to 16 users, while the 2000 model costs from $20,000 to $30,000 and supports 10 to 64 users. Both systems run a version of AT&T's Unix V.3 operating system, though MS/DOS is also supported. Altos' current marketing strategy centers on its local area network product, AdLANtes, which combines either the X.25 or Ethernet protocols with its models 1000 or 2000.

"We have the ability today to go into any shop with a few PCs in it and tie it to an IBM mainframe via an Altos box," says Sam Spadafora, senior vice president for national sales and marketing, speaking about AdLANtes.

According to Spadafora, the Altos system is a hub in the network for communications among the PCs and the IBM mainframe. The Altos system also acts as a shared storage unit and traffic cop for the PCs across the LAN. He adds that any kind of IBM-compatible PC or graphic workstation can be added to an AdLANtes network, which he hopes will open the door for a variety of third-party contracts. Altos sells exclusively to OEMs and VARs.



Robert Neubecker

Altos' net sales are steadily increasing, with $153.9 million for 1987, compared with $134.1 million for 1986. And Spadafora says the company is exploring specialized vertical markets in which to cultivate even more third-party contracts. In March, Altos signed an agreement with Unisyn Corp., a manufacturing VAR in Boulder, Colo., which opens a new niche for the company. Altos sells 30% of its systems to the medical community, with one of its most prominent resellers being Ortho Management in Atlanta. Altos also sells 20% of its systems to wholesale distributors,

20% to manufacturers, 8% to construction and the rest to financial markets.

IDC's Comiskey says that while Altos is strong, "they will be faced with more competition." But, she adds that "they're also the vendor that everyone is trying to catch."

Like Altos, Arix — formerly known as Arete Systems Corp. —sells exclusively through third-party channels. "And we believe we can continue to grow by selling through OEM and VAR contracts," says Mike Lambert, vice president for marketing and sales.

Arix's largest and most publicized OEM is Unisys Corp., which accounts for over 70% of Arix's revenue. Deane Tierney, Unisys program marketing manager for the Arix products, sells the Arix systems as part of the Unisys 5000 series. He says that the U 5000/95 model starts at $68,000 and supports from 16 to 128 users. The U 5000/85 system starts at $39,900 and supports from 16 to 80 users. Both systems run Unisys System V operating system, release 3.0, which is like the AT&T System V.3.

One market for the models, Tierney says, consists of companies that need a standalone departmental system for distributed data processing, with the system perhaps being tied into other systems via an Ethernet LAN. The other market is the small business that would use either model as a type of mainframe.

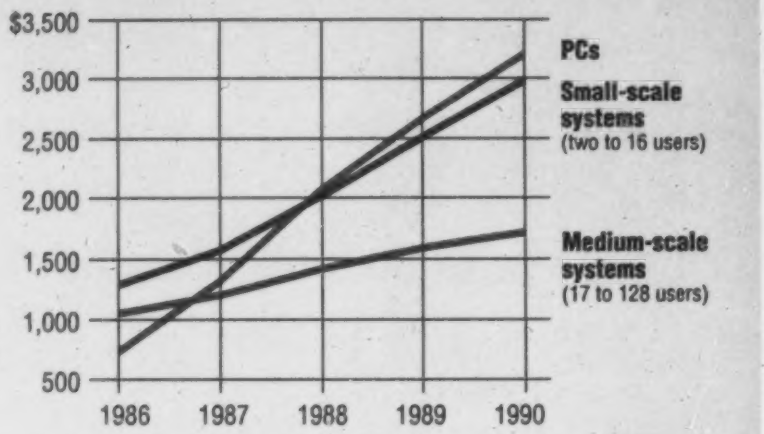
Tierney adds: "Typically, it's a unique solution for the small company, put together with a database software such as Oracle or Informix."

With the February 1988 announcement of the Unisys/Arix contract extension and enhancement, worth up to $150 million over the next three years, Arix's health will continue to be closely linked with the fortunes of Unisys. But Arix's Lambert says the company is aggressively pursuing additional contracts with four or five major system integrators and that Arix is establishing four regional distribution centers. With revenue for fiscal 1987 at $42 million, compared with $30 million for fiscal 1986, Arix is continuing its streak of profitable quarters, says Lambert.

Greg Marus, an analyst with Dataquest Inc., a market research firm in San Jose, says that "[Arix] is smart enough to broaden their market base" and to expand its OEM and VAR contracts.

Unix-based multiuser computer systems market

Sales by U.S. vendors in the U.S. market ($ millions)



	1986	1987	1988	1989	1990
PCs	$746	$1,298	$2,064	$2,683	$3,220
Small-scale	1,285	1,542	2,005	2,506	2,982
Medium-scale	1,054	1,221	1,429	1,600	1,728

Source: International Data Corp.

Diversify

At Plexus, Tom Frederick, vice president for marketing, says that the company is not hearing the word "consolidate." Plexus is hearing the word "diversify" — very loudly.

"As the Unix market matured," says Frederick, "we found that our customers wanted more than just a box. Customers wanted us to sit down and help them solve a problem."

Plexus listened to its customers. The company found that 80% of its customers used the Plexus systems to solve database problems. New technologies for gathering data, such as scanners, imaging devices and new storage devices such as optical disks, were just some of the new peripherals customers wanted to integrate into a single system. The result is that Plexus created its XDP (extended data-processing) series to help manipulate and store "compound data:" text, images and numbers. Frederick says that XDP is "the natural evolution of our database product."

So Plexus changed its market niche by opening up a new one. In 1987, says Frederick, 60% of Plexus' sales went through third-party channels and integrators; 40% went directly to end users. Where once Plexus was selling systems at a base price of about $25,000, it now sells its XDP system at a base price of about $75,000, although the average price is in the hundreds of thousands. Sales for the nine months between the XDP's debut in March 1987 and December 1987 reached $15 million.

Plexus also sells direct to end users, unlike Altos and Arix, and it has been expanding its salesforce. In effect, Plexus is becoming a supermicro company that is competing with systems such as Wang Laboratories Inc.'s Integrated Image System and Eastman Kodak Co.'s Image Management System.

So what does the future hold?

In dollars and cents, analysts say that the Unix multiuser market is strong and is expected to grow. Altos and Arix have looked at their competition in the marketplace and have decided to strengthen their offerings through a variety of OEM and VAR contracts. Plexus, on the other hand, has decided to branch out in a new direction. But all three companies are ready for the next perilous phase of the maturing Unix multiuser market: its adolescence. □

Optical scanners: Patience has finally paid off

It took over a decade, but improved technology and marketing are finally pushing scanner sales skyward

BY BRIAN DEAGON

After 15 years of development and marketing, the manufacturers of optical scanners are beginning to envision healthy market growth.

Although optical scanner technology — sometimes just called scanners — emerged from labs in 1970, only 11,000 products were shipped in 1986 in the United States and Europe. But what a difference a year makes. In 1987, scanner shipments more than tripled to roughly 39,000 units, reports San Jose-based market research firm Dataquest Inc. Combined revenue topped $110 million. Dataquest forecasts that in 1991, about 379,000 scanners will be shipped, totaling roughly $645 million in revenue. Unit shipments will grow 63% annually between 1987 and 1991.

Scanner manufacturers couldn't be more pleased. Many of them have nurtured this slow-growth industry with new products for more than 10 years. Scanners were touted as the elixir for information overload in paper-intensive industries, but users found more problems than solutions.

"This industry is two years behind where experts thought we'd be," relates Jim McNaul, vice president for strategic planning for Datacopy Corp., in Mountain View, Calif. One reason is that manufacturers failed to convince users that optical scanners were beneficial to business. Morever, the scanner industry was late in defining its niche markets.

In practice, many scanners got poor reviews from users. "Some days they work perfectly. Other times they just won't read a page," says Denise Provost, a communications manager for the Boston-based law firm of Mintz, Levin, Cohen, Ferris, Glovsky & Popeo Inc., which has used scanners for seven years.

Manufacturers have been challenged to design scanners that read a multitude of font styles. Early versions could read only three font styles. U.S. and Japanese firms struggling with scanner problems have found solutions mostly through software development.

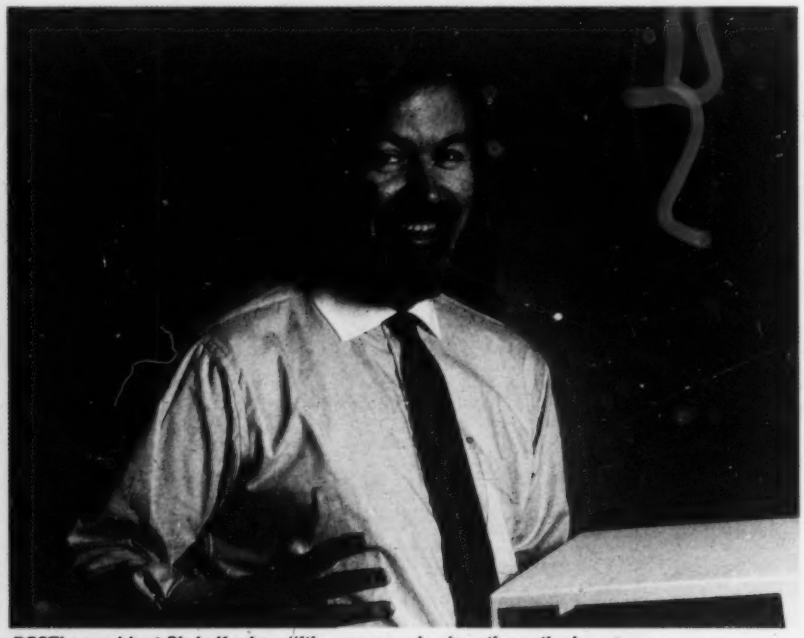
For instance, several manufacturers sell software by OCR Systems Inc. of Bensalem, Pa., as an option. The software enables a scanner to read upward of 2,000 different variations of type sizes and more than 10 foreign languages.

"There will always be an error rate," says Gregory Boleslavsky, OCR Systems vice president. "But we've passed the threshold where it's finally cost productive to use scanner technology. The vital difference is that four years ago only 5% of documents could be read. Now it's 80%."

Scanners that read data only use optical character recognition (OCR) devices. OCR technology recognizes scanned data by matching the images with what's stored in computer memory.

Another variation, called image scanners, reads photographs, line art or graphics and then translates them into computer language. Image scanners were introduced in the early 1980s and have played a key role in the emergence of a low-end market.

Image scanners can be purchased for about $2,000. OCR techniques can be added for an additional $500 in software. Combined image/OCR



DEST's president Chris Kenber: "It's enormously clear the optical scanner market is beginning to take off"

Tim Davis

capabilities previously cost about $10,000. When they were first introduced they cost upward of $50,000. More enhanced image/OCR scanners can read hundreds of font variations and provide more than 250 shades of gray scale coloring of images at 400 dots-per-inch resolution.

"A lot had to come into place for this industry to grow," says Steve Nickel, director of The Technology Group in Evanston, Ill. "Scanners needed to be reasonably priced, distribution channels and user awareness had to emerge, and an infrastructure of applications needed to be identified," he adds.

Key developments needed to accelerate market demand include the introduction of optical scanners with multiple capabilities. Scanners now read data as well as images. Other promising developments include the proliferation of new add-in boards that make scanners work just like a facsimile machine. Computer-based communication systems will be one of the fastest growing segments of the image communication market, predicts CAP International Inc., a market research firm located in Marshfield, Mass.

One early scanner leader, DEST Corp., based in Milpitas, Calif., entered the rapidly growing facsimile market in July 1987 through the acquisition of Gulfstream Micro Systems Inc.

DEST appears well poised for market growth. The company is now showing its second-generation high-end image scanner to vendors and has dropped the price on its first-generation product from $10,000 to $6,000. This event comes six months after the introduction of its second-generation low-end scanner, which works with both IBM and Apple Computer Inc. systems.

"It's enormously clear the optical scanner market is beginning to take off," grins Chris Kenber, DEST president and chief executive.

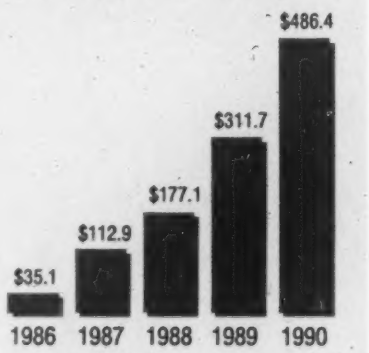
DEST had to pay hearty dues along the way, however. In the early 1970s, DEST was one of the first companies to introduce an OCR scanner which was embraced by legal and financial firms with large word-processing departments. However, it could only read two kinds of fonts and the machine was often confused by nonstandard page design.

Another impetus to growth has been the boom in desktop publishing. As scanner features rise and prices fall, they become a complementary peripheral in that market. "Scanners are a natural tool for selling desktop publishing systems," says Graham Harding, engineering vice president for scanner manufacturer Micro Technology Products, in Gardena, Calif. "Desktop publishing has come of age and people always want to add more to it," asserts Harding.

One dilemma is that the OCR-only scanner market is not expanding fast enough, says Michael Perkons, general manager for CompuScan Inc., a scanner manufacturer in Fairfield, N.J. Although retail pricing has dropped tenfold, service and distribution costs have remained the same, he says. In addition, dedicated OCR devices costing about $10,000 can now be replaced with OCR/image scanners for under $5,000 for general office use.

Desktop scanners

North American market ($ millions)



Source: Dataquest Inc.

Revenue and shipments of dedicated OCR scanners peaked in 1986 at $44.8 million and 3,400 units, CAP reports. OCR shipments will decline roughly 10% a year through 1991.

Enter the Big Three

Many observers say an industry shakeout in the optical scanner market is developing. Eyes are poised on IBM, Apple, and Xerox Corp. These three have yet to take bold steps that could change the shape or direction of the market, although they are in a position to do so, observers note.

Hewlett-Packard Co. is another company being watched. HP has had noteworthy success with its low-end ScanJet for the IBM and compatible marketplace, but it scrapped plans to introduce an Apple compatible scanner last year. Industry observers expect Hewlett-Packard to cause greater ripples in the next two years.

Apple will make its mark soon by introducing its first image scanner in the second quarter of this year, several analysts say. Dataquest has revised its market figures upward to account for Apple's anticipated presence. It predicts Apple will ship 18,000 scanners in the second half of 1988.

IBM has had only limited success in the scanner market, but is predicted to be tough competition if it antes up more funds for development and marketing. IBM's two scanner models are outdated, analysts note.

Xerox's anticipated entry into the scanner market is likely to be leveraged on the success of Cambridge, Massachusetts-based Kurzweil Computer Products Inc. Kurzweil, a Xerox company, is a leading supplier of high-end optical scanners. It is the first major company to integrate artificial intelligence technology into scanner products.

Kurzweil's so-called intelligent character recognition (ICR) technology is envied by the competition. ICR technology can electronically repair characters that may have faded or were improperly joined by poor reproduction. The product, with 4-megabyte RAM, can scan five languages and costs $11,950.

Eyes are also on three key suppliers of scanner engines. They are: Canon U.S.A. Inc; Ricoh Corp., based in Japan; and Taiwan-based Microtek Lab Inc. All three not only supply the engines on an OEM basis, but also sell their own brand-name scanners through regular distribution channels, including retail.

For example, Kurzweil buys its engines from Ricoh, Hewlett-Packard buys from Canon, and Texas Instruments Inc. from Microtek. DEST is the only major manufacturer that builds its own engines. IBM makes its scanners in Japan.

"It's becoming a very competitive market from a vendor's perspective," says Ed Wong, Dataquest research analyst. "If vendors base their product on one of three engines, the only difference is software and pricing." □

Flexible printed wiring reaches for consumer markets

Japan leads in flex for consumer uses; the U.S., in military. Both are growing, but it's hard to bend high prices

BY ALBERTO SOCOLOVSKY

Open the back of Polaroid's new Spectra instant camera. Easier yet, peer inside the Onyx model, which has a translucent back. A small, rigid printed circuit will be very visible. Look harder; around it, you will see flexible printed circuits at work, one flexing when the back opens, another folded into recesses and around corners to reach the controls in the camera's frame.

This camera is a good application for the two types of interconnection jobs that flexible printed wiring is called upon to perform, says Craig B. Self, Polaroid Corp.'s technical purchasing agent. There's the dynamic application, in which "flex" connects to a moving element, as in the camera's cover; and the static application, where they are "folded, contorted and crammed," to fit into tight spaces.

More stressful dynamic applications can be found in computer peripherals such as hard disk drives and printers, where flexible wiring connects to the rapidly moving slide arm or printhead, respectively. In addition to consumer and computer products, other nonmilitary applications such as automobiles, cellular phones and portable medical electronics equipment promise to fuel the growth of printed wiring in the next decade.

Polaroid's Spectra instant camera features both dynamic and static applications of flexible printed wiring

This should be good news for the merchant makers of flex because the military market, where flex was born more than 30 years ago to wire snugly packed space vehicles, is not expected to grow much in the next five years. Yet, military applications of flexible printed wiring, many of them captive, last year accounted for more than half of the $400 million U.S. market, according to the research firm William Jacobi & Associates of Bennington, Vt. By contrast, Japan has a market of the same size, but with no military content.

"In both countries, fabricators have felt protected from the outside world," says president William Jacobi. "In the U.S., because defense markets won't allow foreign intrusion. And, in Japan, because the user base is there; in square feet, they've 85% of the world's production of flex." Japanese designers of electronic equipment are well trained in the applications of flex, whereas in the United States, says Jacobi, "we think in mil specs; many fabricators are not used to responding quickly to nonmilitary users."

Already, the independent makers of flex, which Jacobi ranks the two largest as Sheldahl Inc. of Northfield, Minn., and Rogers Corp. of Rogers, Conn., derive most of their revenue from nondefense users, and have automated roll-to-roll, continuous print-and-etch processes to reduce fabrication costs. The third-ranked company, Parlex Corp. of Methuen, Mass., is largely military. Sheldahl and Parlex have been expanding, through acquisition, into each other's turf. In fourth place may be GM

Hughes Connecting Devices, in Irvine, Calif., which is mostly military but trying to wean itself from dependence on its big defense parent. Hughes' commercial cousin, GM Packard Electronics, all captive to GM, may be the largest fabricator of flexible circuits in the United States, primarily polyester-based flex for dashboards.

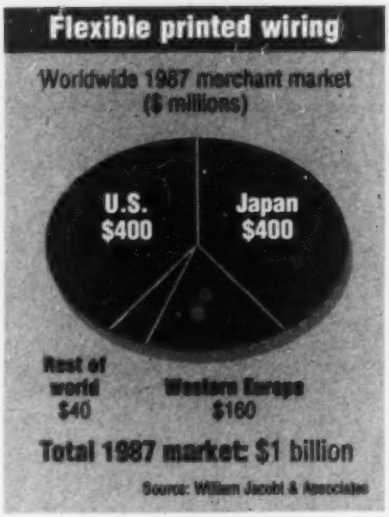
The three leaders expect the flex market to grow by 20% this year, because the potential applications for flex are multiplying. "It's no longer a niche market," explains Harvey Miller of Kirk-Miller Associates, a consultancy in Palo Alto, Calif., that specializes in the printed circuits field. Miller offers two reasons, one marketing and one technological, for flex's fair future: "Think of all the new electronic equipment that is becoming smaller, like cellular radios," he says, "and how well flex lends itself to surface mount components."

Price isn't so flexible

Yet, for flex to expand its markets, price also has to become more pliable. All military flexible circuits are built with several layers of copper-clad polyimide, a heat resistant, dimensionally stable but more costly plastic film. Polyimide is the preferred substrate; not just for high-temperature duty, but in general, because it does not degrade in assembly while soldering the circuit's components. Du Pont Electronics is the major supplier of the film, under its Kapton trade name, which it sells to laminators such as Fortin Industries Inc. of Sylmar, Calif., and Sheldahl.

Two years ago, Du Pont Electronics introduced its own laminate for flexible printed wiring, a copper-clad Kapton called Pyralux, and is already the United States' largest vendor of copper-clad polyimide. According to the Institute for Interconnecting and Packaging Electronic Circuits (IPC), polyimide owns more than 60% of the flexible laminates market in the United States, followed by polyester, which is less heat resistant but costs about one-third the price of polyimide.

Sheldahl is the polyester flex leader. "With 60% of our [$70 million in 1987 flex] sales, we're the clear leader in commercial circuitry," says Keith Casson, director for technical marketing. Sheldahl makes the flex for Polaroid's Spectra camera,



and is a major supplier to Texas Instruments Inc.'s educational toys and to Ford Motor Co.'s dashboard wiring. Rogers, which counts IBM as a big customer for polyimide flex, has developed a low-cost material for static applications. Called Bend/flex, it can bend once to fit into the package and stay there without further bending.

Polaroid opted for the lower cost film even though its lower temperature rating "makes it more difficult to solder the SM components," says Self. But it also selected rolled annealed copper, a more ductile but more expensive cladding than electrodeposited copper.

Military uses of flexible printed wiring last year accounted for over half the $400 million U.S. market

However, the higher price of flex versus rigid printed wiring is offset by its simpler packaging. "You need fewer cables and connectors," says J. Lee Parker of AT&T's Bell Laboratories, in Richmond, Va., who chairs the IPC's design committee for flex. "This improves reliability and reduces cost."

IBM has evaluated extensively the reliability of SMC assemblies on flex. "It's a good match," says Jeffrey A. Collett, staff engineer at IBM's Application Business Systems division in Rochester, Minn., "because the substrate is compliant. But this property makes assembly harder to automate, because it's difficult to hold the substrate planar."

Not every OEM has that kind of expertise. "I was visiting Tandon's [disk drive assembly plant] in Singapore a few years ago," says Dr. Carmelo J. Santoro, chairman of Silicon Systems Inc., a Tustin, Calif., supplier of ASICs for Winchester disk drives, "and saw the yield loss they were taking in mounting chips on flex." To supply tested flex assemblies to such customers, SSI joined with Rogers in a venture called Smartflex Systems. So far, Smartflex has been more successful with high-end disk drive makers, such as Maxtor Corp., than with Tandon and other low-end vendors, because the assembly represents a smaller portion of the total cost in a high-end drive. "Purchasing people don't value the value we add," laments Santoro. "The real sell is at engineering, manufacturing, and quality management."

Since many Japanese electronics manufacturers are already sold on flex, the eyes of American flex suppliers are on the Stateside operations that Japanese automobile and consumer electronics OEMs are opening. "We've a strategy to penetrate these companies," says Sheldahl's Casson. Some of that strategy is based on Japanese connections; Sheldahl has a reciprocal minority ownership deal with Sumitomo Bakelite, and Rogers has a joint venture, Rogers Inoue Corp.

But Japanese suppliers are not ready to give up their customers; they even may try an end run to capture U.S. accounts by leveraging their experience in SM and in mass production. "Japan's [Nippon] Mektron is the largest supplier of flex in the world," says Du Pont Pyralin marketing manager, Calvin Cruz. "They've a high volume 'roll-to-roll' process." Nippon Mektron, which was a Rogers licensee until 1986 and can use in Japan the Rogers-owned Mektron name, already has been courting the big U.S. OEMs. "But we're not worried about pricing anymore," says Rogers' marketing director Robert D. Wachob. "The world has changed." □

Can MAP make it on the factory floor in 1988?

So far, the factory network's shifting specs have scared off customers. As MAP 3.0 wares debut, 1988 may be different

BY SYLVIA TIERSTEN

MAP — Manufacturing Automation Protocol —is an idea whose time has been coming — and coming — and coming. In mid-1984, General Motors Corp. offered a feasibility demonstration of the factory floor computer networking protocol at the National Computer Conference, which "really whet people's appetites," recalls Michael Kaminski, GM's manager for advanced manufacturing engineering.

In early 1985, GM upped the ante by announcing MAP specs and promising to "keep them in place at the vendors' request for at least two years," according to Kaminski. The protocol, intended to establish a standard means of communications between computers and production cell equipment from many different vendors, appeared at the Autofact '85 show in its 2.1 broadband version, which supports multiple data channels simultaneously.

Roughly six months later, 2.1 products became available. Although GM implemented several 2.1 and 2.2 (carrier band) systems, a number of potential vendors and customers played a waiting game. "It was apparent early on that the 2.X standards were only emerging ones," recalls Julie Pingry, editor of the *CIM Strategies* newsletter in Arlington, Mass.

GM's MAP master, Mike Kaminski: "MAP equipment vendors knew we were continuing to develop [the specs] so they decided to wait"

Junebug Clark

Hailed as the year that MAP would take off, 1986 wasn't — and MAP didn't. "They [the MAP equipment vendors] knew we [GM] were continuing to develop functionality within the 1988 time frame," says Kaminski, "and when they heard that, they decided to wait for it. In a sense, we were the victims of our own enthusiasm."

To date, MAP hardware and software have failed to make a serious impact on the factory floor, leaving Ethernet-based proprietary networks like Digital Equipment Corp.'s DECnet and Hewlett-Packard Co.'s version with the upper hand. Market research firm Venture Development Corp. (VDC) of Natick, Mass., puts Ethernet's share of the 1987 market for industrial LANs at five times that of MAP. Researcher, Dataquest Inc., estimates that in 1987, not more than $29 million worth of broadband MAP products were shipped.

This may be about to change. One recent issue of a market research newsletter was headlined: "MAP vs. Ethernet: The battle is on." Some MAP proponents now see 1988 shaping up as a pivotal year for the technology — and the Enterprise Networking Event (ENE) '88 as a pivotal show. The June 5 through June 9 ENE exhibit in Baltimore will serve, among other things, as a launching pad for new 3.0 MAP products. This latest MAP version promises more functionality than its 2.X predecessors — and a considerably longer shelf life. The reason? From June 1988 through June 1994, 3.0 network specifications will be frozen for upward capability.

"The MAP/TOP (Technical and Office Protocol) Users Group lobbied hard for that freeze," says Robert S. Crowder, president of Ship Star As-

sociates in Newark, Del., a CIM/MAP consulting firm. Apparently, he adds, "GM thought stability was only important to the vendors. I don't think they perceived the extent of the problem — particularly among users in some of the smaller companies." For example, robot makers, faced with a narrow marketplace and fluctuating standards, have been unwilling to invest heavily in high-performance MAP interfaces.

Freezing the specs

According to Julius Dorfman, president of market research firm Cimdata Inc., Wellesley Hills, Mass., the six-year freezing of standards will produce 100% annual growth in the sale of broadband MAP products over the next few years.

Unlike Autofact '85, the Enterprise show is "an exhibition of deliverable product and not just another demonstration project," says industry analyst Bob George of San Jose-based Dataquest Inc. He thinks that this year "will prove that MAP is real." George cautions that fiber-optics networks could cut into projected broadband MAP sales as their price performance rises.

Offering a more guarded assessment is VDC analyst James K. Brown, who recently surveyed large users of factory communications networks. Brown's worst-case scenario is an unsuccessful Enterprise show in which 3.0 products simply fail to work. A second, somewhat less ominous possibility, he says, is "a narrowing of the amount of things they try to do with the network at the show, which would also be a kind of failure."

Until now, he contends, MAP has failed to take the advanced manufacturing market by storm because "a lot of people don't want to bet their factory on a new and unproven technology." And even if Enterprise '88 is a huge success, neither Brown nor anyone else expects proprietary networks to vanish overnight.

"Vendors want to squeeze as much as they can out of those proprietary networks, so it makes sense for them to continue support for those products," says Mark Shaw, senior administrator of the Society of Manufacturing Engineers' (SME) MAP/TOP Users Group in Dearborn, Mich.

The primary focus of the upcoming Enterprise show is on using open systems interconnection (OSI) to custom manufacture products in a multivendor, computer-integrated environment. "This is the first show that I know of with multivendor capability on one network," says the SME's Shaw. "What we've seen before is little islands of proprietary networks." Look for "a very steep curve of MAP and TOP implementations" by mid-1989, with some leveling off in the market in the 1991-1992 time frame, adds GM's Kaminski.

Unlike earlier MAP versions, 3.0 specifications offer some degree of functionality at all seven protocol layers. These are, in ascending order: physical; data link; network; transport; session; presentation; and application.

The freezing of standards is expected to produce 100% annual growth in sales of broadband MAP products over the next few years

The presentation layer, which earlier MAP products did not contain, provides translations between standardized data formats. MAP 2.1 and 2.2 also lacked network management capability and directory services in the seventh, or application layer. The 3.0 version "is not anyone's idea of the optimum network management service," says Charles Chriss, marketing vice president for Retix, a Santa Monica, Calif., supplier of OSI protocols. Nevertheless, he contends, "there is now sufficient functionality for practical networking."

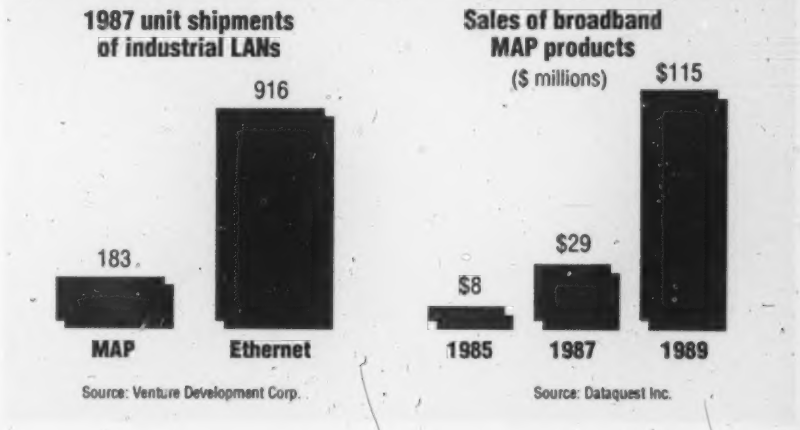
Migration from a 2.1 to 3.0 environment will involve some incompatibilities, particularly at the upper layers, as will migration from proprietary local area networks. "HP, IBM and DEC are all looking at how they can integrate with OSI," says Shaw. Ethernet, for instance, which runs on 802.3 media, would encounter compatibility difficulties mainly at the top MAP layers.

Migration is a critical issue. According to Paul DePond, director for product marketing of systems software for networks vendor Ungermann-Bass Inc., of Santa Clara, Calif., people will not buy MAP 2.1 unless vendors at the ENE exhibit "can show an absolute migration to 3.0 that is not too expensive." As for MAP's ultimate fate in the marketplace, issues of cost and utility still remain: process control and automotive manufacturers value the noncollision aspects of 802.4 token-bus, but other types of manufacturers may find less costly proprietary LANs more than adequate.

The higher price of MAP

Currently, MAP products sell for roughly twice as much as proprietary LANs. The upfront cost for a serial communications board for small networks of GE Fanuc programmable controllers is $1,500, as opposed to

So far, MAP products aren't hot items



Do yourself a service Let ELECTRONIC BUSINESS readers know about your services

Next August 15, ELECTRONIC BUSINESS will publish its annual directory of Services for the Electronics Industry. If your company can help other electronics and computer companies complete a project on time, save costs, reduce risk, get to market faster and safer, increase efficiency, improve quality, or any other pertinent electronics service, the name of your company or division, and the type of service it provides for our readers, belong in the pages of the ELECTRONIC BUSINESS directory.

Example of services that will be listed:

Design: product design, circuit design, custom ICs, design centers, software development, package and packaging design, thermal design, documentation.

Manufacturing: contract manufacturing, printed circuit design and fabrication, mass lamination, purchasing services, kitting services, value added services, cabling, connector assembly, quality assurance service, just-in-time services, component procurement services, production software services, electrostatic discharge protection services.

Test: electrical test services, environmental testing, failure analysis, instrument rental services, test software development, production testing.

IC Foundry: silicon, CMOS, custom processes, gallium arsenide.

IC Assembly: die attachment, wirebonding, packaging, marking, sorting.

Distribution: services by and for industrial distributors, distribution channels, dealers, packaging for distribution and retailing, point of sale services.

Training: quality training, statistical production control, JIT training, purchasing, negotiating, management training.

Management: product strategy, global strategy, international operations, management consulting, temporary additions to management team.

Marketing and Sales: strategy, market research, product strategy, product position, sales representation, product promotion, export promotion, advertising, public relations.

Financial: leasing, banking, insurance, venture capital, mergers and acquisitions.

Transportation: freight forwarding, air cargo, customized packaging.

How to submit your listing:

- Name, address and telephone number of company or division that performs the service. If available, add telex and fax numbers.
- Type of service: Please be specific. (If you enter in more than one category, such as design and manufacturing, please list separately.)
- Name of manager(s) responsible for services for electronics and computer companies. Include direct telephone number, if available.
- Current volume of sales of this type of service to electronics and computer companies.
- Number of employees at this company or division, involved in this type of service.
- Specialized equipment, knowledge, and/or capabilities, which qualify your operation to perform this service. (Please list or describe in 50 words or less.)
- Name of at least one client among electronics and/or computer companies.

Send your entry, before April 30, 1988, to:

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Electronic Business

$3,150 for a MAP interface, according to Henrik Schutz, senior product planner for GE Fanuc Automation North America. A standardized network, however, can reduce costs associated with training, installation, maintenance, spare parts inventory, updating, wiring, custom hardware and software. As MAP gains market credibility, prices should come down, say industry participants. Motorola Inc. is already offering a carrier band, single-channel MAP interface for under $1,000.

In its present version, MAP can transmit data at the rate of 10 megabits per second on a broadband and 5Mb on a carrier band. An important, if sometimes overlooked MAP advantage over Ethernet, is MAP's

Some MAP proponents see 1988 shaping up as a pivotal year

ability to run Manufacturing Messaging System, an applications protocol for machine-to-machine communications that works well with robots.

For some factory applications, proprietary LANs outshine MAP in functionality terms. "If you have two robots," says GM's Kaminski, "and you want to move something from one arm to the other — you may want to link them with proprietary protocol." A high-speed camera might talk to a robot via a non-MAP protocol, but you still ought to have MAP capability to link up vision devices to the computers above them," he says.

Some customers maintain that users will ultimately demand MAP — and get it. One that has invested heavily in automation is agricultural machinery maker Deere & Co. Says Gary Blunck, project manager of Deere Technical Services: "The fallacy that we hear from DEC and some of the other vendors is that they are only talking about a closed environment. But large companies like ourselves with diverse equipment find that installing multiple proprietary equipment is just too much of a headache."

Sylvia Tiersten is a San Diego-based business writer

The element of overseas

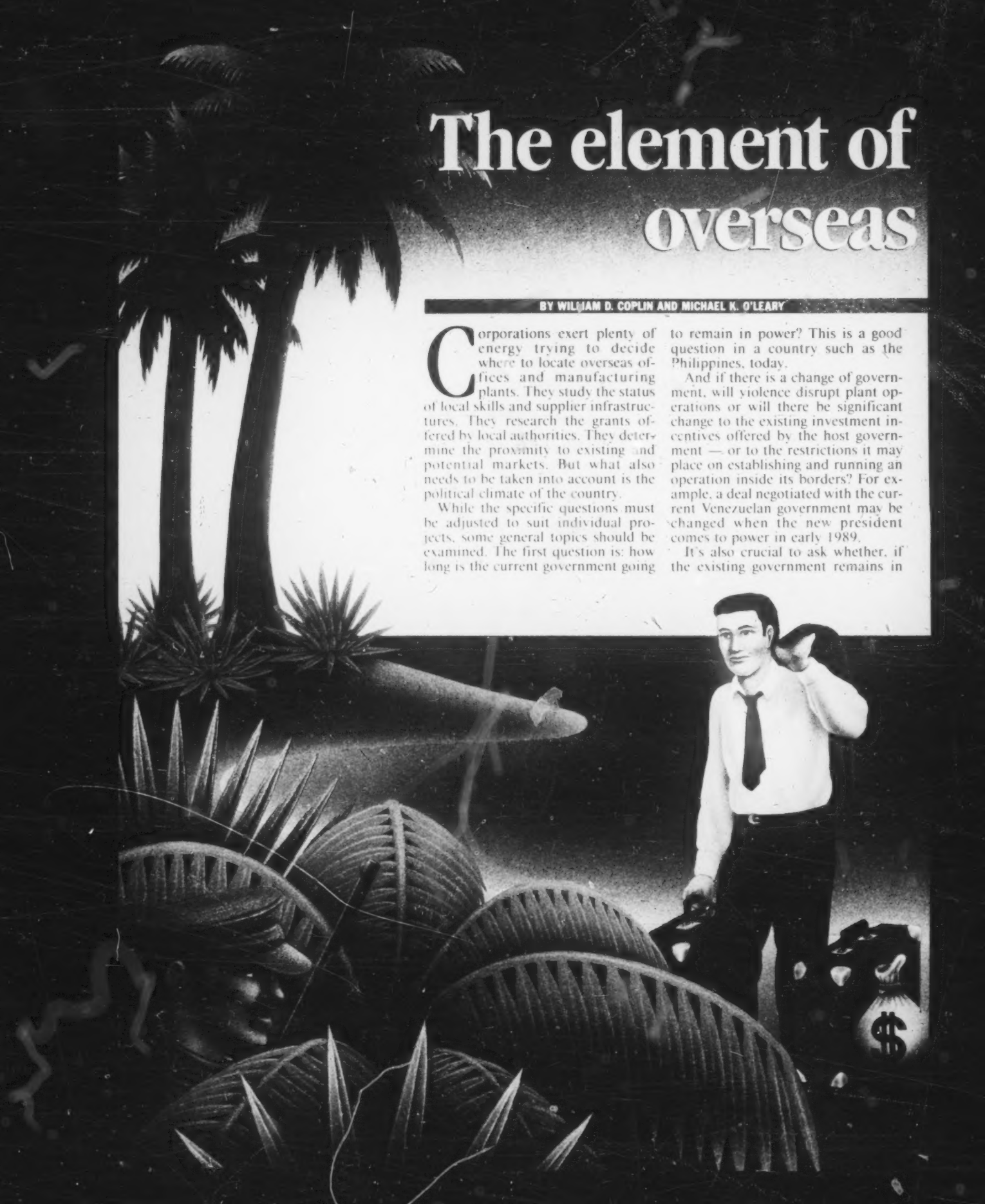
BY WILLIAM D. COPLIN AND MICHAEL K. O'LEARY

Corporations exert plenty of energy trying to decide where to locate overseas offices and manufacturing plants. They study the status of local skills and supplier infrastructures. They research the grants offered by local authorities. They determine the proximity to existing and potential markets. But what also needs to be taken into account is the political climate of the country.

While the specific questions must be adjusted to suit individual projects, some general topics should be examined. The first question is: how long is the current government going to remain in power? This is a good question in a country such as the Philippines, today.

And if there is a change of government, will violence disrupt plant operations or will there be significant change to the existing investment incentives offered by the host government — or to the restrictions it may place on establishing and running an operation inside its borders? For example, a deal negotiated with the current Venezuelan government may be changed when the new president comes to power in early 1989.

It's also crucial to ask whether, if the existing government remains in



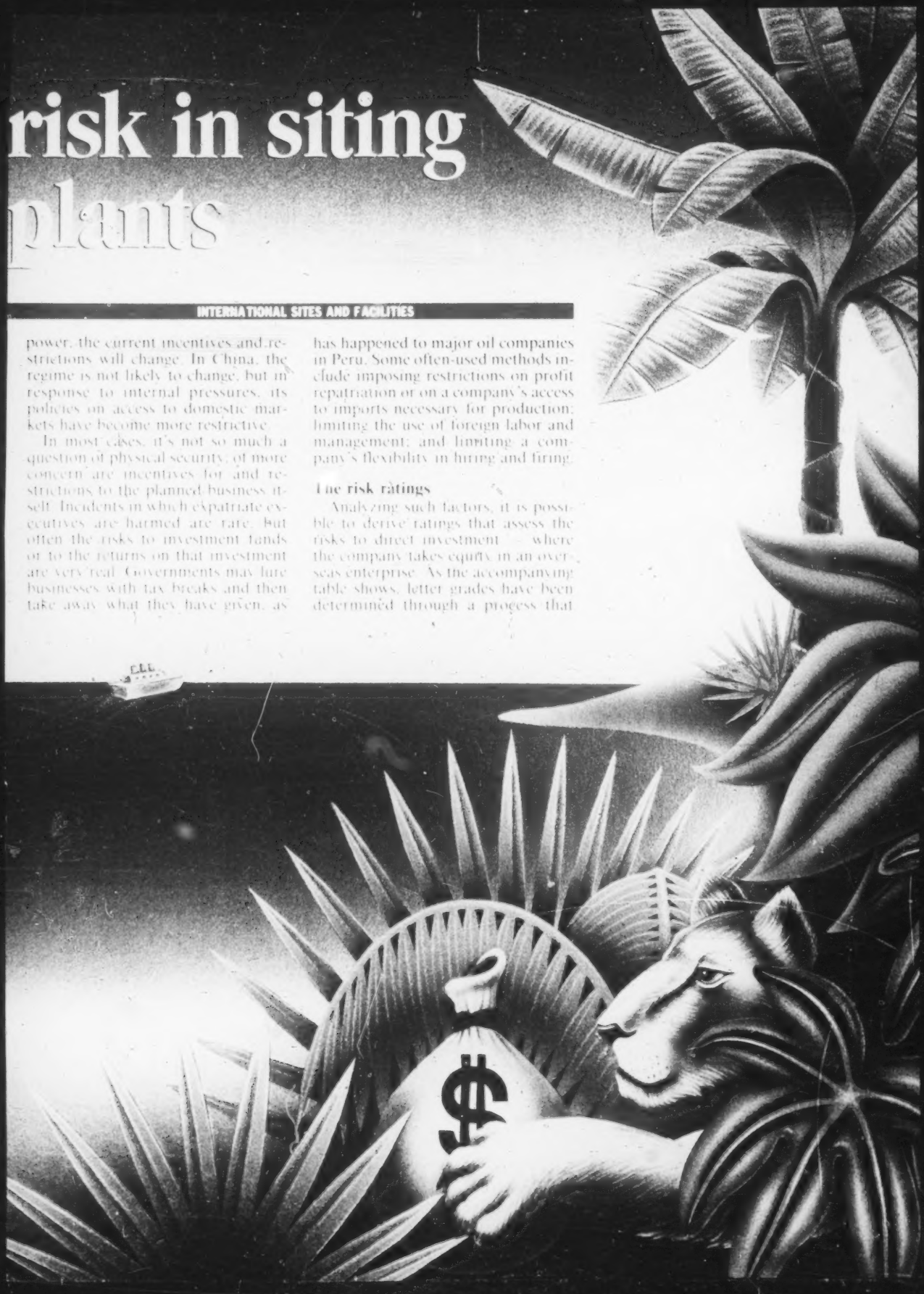
risk in siting plants

power, the current incentives and restrictions will change. In China, the regime is not likely to change, but in response to internal pressures, its policies on access to domestic markets have become more restrictive.

In most cases, it's not so much a question of physical security; of more concern are incentives for and restrictions to the planned business itself. Incidents in which expatriate executives are harmed are rare, but often the risks to investment funds or to the returns on that investment are very real. Governments may lure businesses with tax breaks and then take away what they have given, as has happened to major oil companies in Peru. Some often-used methods include imposing restrictions on profit repatriation or on a company's access to imports necessary for production; limiting the use of foreign labor and management; and limiting a company's flexibility in hiring and firing.

The risk ratings

Analyzing such factors, it is possible to derive ratings that assess the risks to direct investment — where the company takes equity in an overseas enterprise. As the accompanying table shows, letter grades have been determined through a process that



projects the risks to foreign investment in wholly owned subsidiaries, joint ventures, and other forms of direct ownership of assets. Making these assessments requires the combination of information about the level of risk, forecasts of the three most likely regimes, and an evaluation of risks to business. For short-term forecasts, Frost & Sullivan evaluates the following risk factors:

- turmoil;
- equity restrictions;
- restrictions on local operations, including policies related to labor, management, and procurement;
- taxation discrimination;
- repatriation restrictions;
- exchange controls;
- labor costs.

In making five-year forecasts, the short-term forecast is calculated along with:

- the long-range outlook for turmoil;
- the relative strength of forces supporting and opposing restrictions on international investment;
- the forecasts of change under three most likely 5-year regime scenarios;
- the country's ranking and prospects on domestic and international economic indicators.

To answer questions about the present and future political climate, electronics executives need to draw on individuals and groups with substantial expertise on the underlying factors that determine the country's environment for international business. They need to be careful not to rely on sources that have a vested interest in the status quo, for instance, banks, the U.S. government, or the host government; or those with vested interest in change, such as political risk insurance companies, newspapers, and opposition politicians.

In essence, it is important to remember the underlying political climate and the potential for significant changes. The key is to know who's in power, who is likely to be in power, and whether policies — therefore, incentives and restrictions — are likely to change.

Coplin and O'Leary are directors of Frost & Sullivan's Political Risk Services unit

Where it's risky — and where it's not

This is only a partial listing of the nations assessed by Frost & Sullivan. ELECTRONIC BUSINESS has, because of space constraints, chosen only those countries it believes have the strongest presence in the electronics industry.

Under each country is the date of Frost & Sullivan's last update or report, followed by the 18-month (top row) and 5-year (bottom row) political forecast: with, left to right: risk ratings for turmoil (low to very high); and ratings (A+ the least to D- the most) for the risks to transfer of funds; to direct investment funds and exports to the country. Parentheses indicate a recently updated forecast.

	Turmoil	Funds transfer	Investment	Export
Argentina	Moderate	C+	B-	C
(11/87)	Moderate	C	C-	D+
Australia	Low	A	A	A-
(8/87)	Low	B+	A	B
Austria	Low	A+	A	A+
(6/87)	Low	A+	A+	A+
Belgium	Low	B+	A	B+ (A-)
(6/87)	Low	B+ (A-)	A-	B+
Brazil	High	D	C	D
(12/87)	High	D+	C-	D
Canada	Low	A-	A-	A
(11/87)	Low	A-	B+	B-
China	Low	B-	B	C+
(12/87)	Moderate	B-	C+	C-
Egypt	Moderate	C-	B	C-
(7/87)	Moderate	C	C-	D+
France	Moderate	A-	A-	A-
(9/87)	Moderate	B+	B+	B+
Hong Kong	Low	A+	A	A+
(1/88)	Low	A+	A (A+)	A+
India	Moderate	B	B	B
(11/87)	Moderate	B-	A-	B+
Indonesia	Low	B-	B+	B-
(9/87)	Low	B	B	B-
Ireland	Low	A-	A	A
(8/87)	Low	A	A-	A-
Israel	Moderate	C+ (B-)	A-	B-
(1/88)	Moderate	C+ (B-)	B+ (A-)	B
Italy	Low	B+	A+	A
(12/87)	Low	B	A	B+
Japan	Low	A+	A	A+
(11/87)	Low	A+	A-	A

	Turmoil	Funds transfer	Investment	Export
Malaysia	Moderate	B+	B+	B+
(12/87)	High	C+	C	C
Mexico	Moderate	C+	B	C+
(12/87)	High	C	D+	D+
Netherlands	Low	A+	A+	A+
(1/88)	Low	A (A+)	A- (A+)	A- (A+)
Philippines	Very high	B-	B	C+
(1/88)	Very high	D+	D+	D+
Portugal	Low	B+	A-	A
(10/87)	Low	B+	A-	B+
Puerto Rico	Low	A+	A+	A+
(1/88)	Low	A (A+)	A+ (A)	A
Singapore	Low	A	A	A+
(8/87)	Low	A	A+	A+
South Africa	High	B	C+	C+
(9/87)	Very high	C+	C-	C-
South Korea	Moderate	A- (B+)	B	A (A-)
(1/88)	Moderate	B (B-)	C+ (C+)	B- (C+)
Spain	Moderate	A-	A	A
(11/87)	Moderate	B+	B+	B+
Sweden	Low	A	A+	A+
(6/87)	Low	A	A	A
Taiwan	Moderate	A-	B+	A-
(1/88)	Low	A	A	A-
Thailand	Moderate	B	B+	B-
(4/87)	Low	B+	B	B-
United Kingdom	Low	A+	A	A+
(10/87)	Low	A+	A-	A-
Venezuela	Low	D+	B-	C
(11/87)	Low	C+	C+	D+
West Germany	Low	A+	A+	A+
(1/88)	Low	A+	A+	A+

Strategies for international manufacturing

An analysis of U.S. firms in Europe suggests alternative methods of boosting foreign sales

Traditionally, when companies talked about international manufacturing, it was described in terms of production in low labor cost countries. Now, however, increasing global competition and changing product cost structures have broadened the objectives and changed the strategy of international manufacturing in the electronics industry. Becoming increasingly important is the role international manufacturing plays in leveraging foreign sales.

There are basically four strategies of international manufacturing which companies can follow: home country manufacturing; coordinated global manufacturing; regional manufacturing; or a combination of the coordinated global and regional strategies. Other strategies, such as tax avoidance or currency management, are usually secondary to one of the primary strategies. The appropriate international manufacturing strategy depends on a company's business strategy. As a result of this strategy, the degree of regionalization in international manufacturing can have a significant impact on success of foreign sales.

Comparing strategies

The table shows the European manufacturing presence for selected electronic equipment and computer manufacturers. When the percentage of European sales is plotted against the degree of European manufacturing for these companies, a strong relationship can be seen. The degree of European manufacturing is based on the number, size and focus of plants in Europe at the beginning of 1986. A few companies such as Apollo Computer Inc. and Compaq Computer Corp. have been increasing their European manufacturing since.

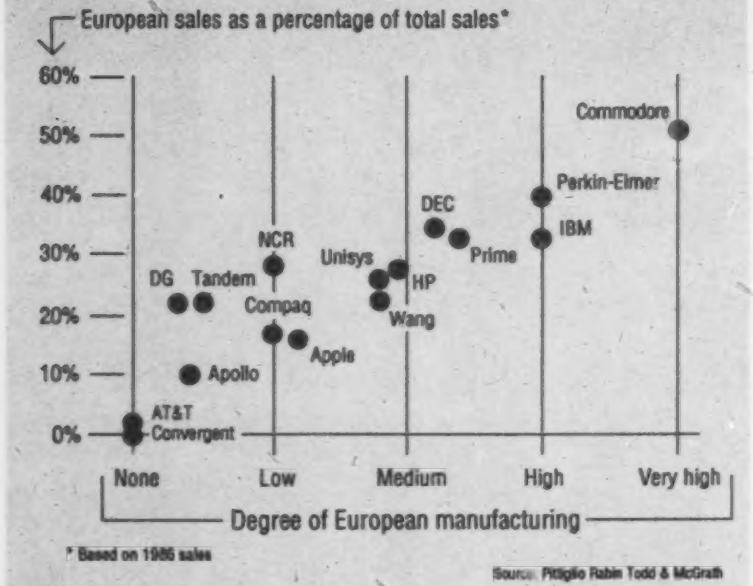
In general, this shows that foreign companies can achieve up to 20% of sales in the European market with little or no local manufacturing. Beyond this point, however, increased manufacturing presence is required in order to achieve higher European revenue. Digital Equipment Corp., Hewlett-Packard Co., IBM, Perkin-Elmer Corp. and Prime Computer Inc. are particularly successful examples. Most of these companies have multiple plants throughout Europe. Prime has a single very large plant in Ireland. Commodore Business Machines Inc. is interesting because it not only has extensive manufacturing in Europe, particularly West Germany, but is even considered by many to be a German company.

This chart shows four quadrants defined by the degree of manufacturing and foreign sales. The quadrant at the upper left, high European sales/low degree of foreign manufacturing, is not a viable strategy. Until recently, it has been a viable strategy for some Japanese manufacturers due to the advantages of manufacturing in Japan and the openness of the European markets, as well as in the U.S. consumer and semiconductor markets. But the world has changed. These markets are less open, and the manufacturing advantage is less significant. As a result, companies like Hitachi Ltd., Matsushita Electric Industrial Co., NEC Corp. and Sony Corp. are strategically moving to the quadrant at the upper right by expanding manufacturing into their markets.

In a recent study on international manufacturing strategies of the large electronics companies, Pittiglio Rabin Todd & McGrath found that companies following a home country or a coordinated global strategy averaged 22% foreign sales, while those with a regional or combined strategy averaged 36%. This difference can really be viewed as a potential increase in total sales of 14% or as an increase in foreign sales of 60%.

The ability to leverage sales through manufacturing is not only confined to a specific country. Regional accords between alliances such as the European Economic Community (EEC); the Andean Pact (a trade agreement between several South

Correlation between sales and manufacturing



* Based on 1986 sales

Source: Pittiglio Rabin Todd & McGrath

European manufacturing presence

1986 sales Company	Total sales ($ millions)	European sales ($ millions)	Percent sales in Europe	Percent assets in Europe	European manufacturing facilities
Apollo	$392	$40	10%	23%	Scotland[1]
Apple	1,902	312	16%	9%	Ireland
AT&T	34,090	NA	NA	NA	England
Commodore	889	455	51%	43%	West Germany
Compaq	625	109	17%	14%	Scotland[1]
Convergent	305	0	0%	0%	None
Data General	1,267	283	22%	15%	None
DEC	9,389	3,252	35%	23%	Scotland, Netherlands, England, Ireland, West Germany, France
Hewlett-Packard	7,102	2,009	28%	19%	England, Scotland, West Germany, France, Spain
IBM	51,250	17,078	33%	32%	France, West Germany, Scotland, Italy, Sweden
NCR	4,882	1,359	28%	21%	Scotland and others
Perkin-Elmer	1,334	534	40%	33%	West Germany, England, Ireland, Liechtenstein
Prime	860	280	33%	29%	Ireland
Tandem	624	136	22%	17%	West Germany
Unisys	7,432	1,949	26%	17%	West Germany, Belgium, France, Scotland
Wang	2,643	602	23%	17%	Ireland, Scotland

[1] Plant under construction during 1986 NA = Not available

Source: Pittiglio Rabin Todd & McGrath

American countries); and the Lome Convention (agreements between European countries and their former colonies); allow companies to sell their products competitively to a broader market by establishing a regional manufacturing presence. This strategy is different from leveraging sales in a single country because it requires finding a common denominator in dealing with mixed cultures and markets.

Applicability

However, the sales leverage to be achieved by regional manufacturing varies by industry segment as well as by the strategy for an individual company. In addition, there are a few other alternatives to manufacturing which can achieve some amount of leverage.

The communications market is strongly regulated by the government in most countries. The controversy over market "allocation" involving France and Germany concerning the ITT/Compagnie Générale d'Electricité joint venture illustrates this control. British Telecom has traditionally purchased most of its telecommunications equipment from companies manufacturing in Britain, although this is beginning to change.

In the computer market, there is a great deal of evidence suggesting that local presence is more important than technology or cost advantage. For example, IBM has the largest market share in each of the major European markets. The second position is held by the indigenous manufacturer; ICL Ltd. in Britain, Siemens AG in West Germany, Groupe Bull in France and Ing. C. Olivetti & Co. in Italy. IBM has extensive manufacturing in each of these countries and is viewed as a world citizen. The other companies do not perform nearly as well outside their home country.

Except for the protectionism factors, consumer electronics are not as susceptible to leverage from manufacturing. Semiconductor and components are viewed in many cases as worldwide commodities and no one really knows where they are "manufactured." There are exceptions, where customer requirements and customer preference are important.

There are also alternatives to foreign manufacturing, such as offset buying, joint ventures and aggressive marketing, which can improve foreign sales. However, the alternatives do not show successful and long-lasting results.

Implications

Clearly then, international manufacturing does leverage foreign sales. The benefit of this is significant. A company with $500 million in sales, for example, could realize an additional 15%, or $75 million, in revenue and $20 million to $30 million increased profit contribution. The impact varies by industry segment and by company, but it does demonstrate that international manufacturing must be an element of a company's business strategy.

While manufacturing in a country doesn't automatically mean increased sales, expecting significant success without an international manufacturing strategy isn't realistic.

MICHAEL E. MCGRATH

Michael E. McGrath is a director of Pittiglio Rabin Todd & McGrath in Weston, Mass.

International manufacturing strategies

Home country manufacturing — Basically, this is a centralized manufacturing strategy with 90% or more of the manufacturing operations conducted in the company's country of origin.

- Companies use this strategy because they believe that their country has the best manufacturing capabilities, or because they sell primarily into their home market.

Coordinated global manufacturing —This is the classic strategy for taking advantage of low labor cost areas for the manufacture of components and subassemblies.

- This strategy is used by companies focusing on product cost.

Regional manufacturing — Manufacturing operations are deployed into major markets.

- This strategy includes both the manufacture of the same products in each market region or the manufacturing of components and subassemblies in each market region.
- This strategy is typical of a company which uses manufacturing to leverage foreign sales.

Combined regional and coordinated global manufacturing — This involves some component or subassembly manufacturing in low cost regions with final assembly in regions where markets are located.

- It is the most sophisticated strategy with the most complex execution and potentially the highest payoff. □

DRAMs sound the alarm for distributors

If prices stabilize, the recovery may be coming to an end. Why do people double order?

A billion dollars separates the sales of Mayer Electronics Co., a regional distributor in Billerica, Mass., from top-ranked Avnet's Electronics Marketing Group. Mayer's sales are under $10 million, while Avnet chairman Tony Hamilton expects that sales by EMG will best the billion-dollar mark in 1988. More important than the sales gap is their view of suppliers' prices of commodity chips. Hamilton thinks prices of dynamic random-access memories are stabilizing now, whereas Mayer's president Jack Derby calls for late summer.

Price stabilization, says Hamilton, marks the fourth phase of economic recovery for distribution. Phase I is signaled by increasing bookings. Increasing shipments are Phase II; suppliers' deliveries stretch out in Phase III; suppliers' prices stabilize in Phase IV; and distributors' profits increase in Phase V. By those criteria, the distributors that NEDA samples to construct its indices for bookings and shipments may be in Phase I or II because shipments are very strong, while the book-to-bill ratio continues to grow from month to month. Two important members of the NEDA sample, Anthem Electronics, a $200 million distributor that specializes in semiconductors; and Marshall Industries, which is twice the size of Anthem; have increased sales by almost 50% in recent quarters.

Leadtimes haven't stabilized either; double ordering, the dreaded side effect of stretching leadtimes, has been plaguing distributors since the beginning of this year. Hamilton claims to ship 70% of the orders "in 90 days or less. But we see some double ordering for 256K DRAMs and for [Intel] '386 microprocessors," he says. So does Mayer: "We get two calls per week from buyers — not from brokers — who want up to 100,000 256K DRAMs," says Derby.

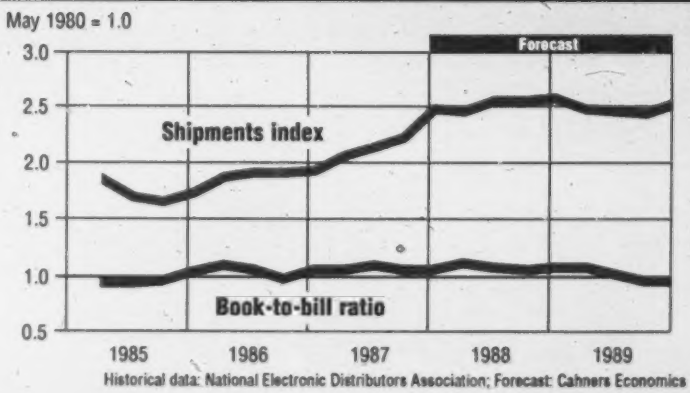
If there is double ordering, how could prices be stabilizing? DRAMs are fetching more than $10 in the spot market. "We could sell [DRAMs] to a black marketeer for twice what we sell to our customers," says Avnet's president Leon Machiz, who heads Time Electronics, a major distributor of Hitachi DRAMs. "But we're not in a price business, we're in a service business."

"No good distributor takes advantage of its customers; buyers have long memories," says Derby. "I have customers who signed up for less than $3; they supported us in the past, and buy other components [besides DRAMs]. With them, if my costs go up, I just try to maintain my margin percentage. I don't want to sell just DRAMs to new customers; we want to make sure that we'll see them all the time after parts become available." Derby, who counts Samsung Electronics as a major line, thinks that 256K DRAMs will become available in the late summer. The reason is that "we've seen more 1 megabit DRAMs lately, at $29 to $34.50." Samsung's ability to deliver the larger chips makes Derby suspect that the purported shortage of Japanese DRAMs is artificial. "I don't believe such great engineering houses have difficulty making them," he scoffs.

Cahners senior economist Elizabeth Baatz forecasts that NEDA's shipments index will rise 15% this year, and that bookings will do even better. That sounds more like Phase I. Even Hamilton, who carries no Japanese lines at Hamilton/Avnet, drools at the market opportunity: "It'd be nice to have a line of Japanese DRAMs, with their huge capacity," he says, wistfully.

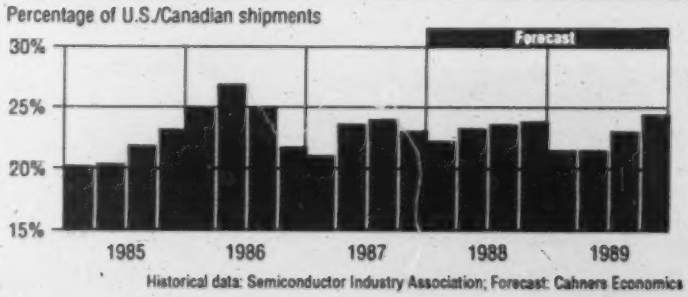
ALBERTO SOCOLOVSKY

Distribution business index



Historical data: National Electronic Distributors Association; Forecast: Cahners Economics

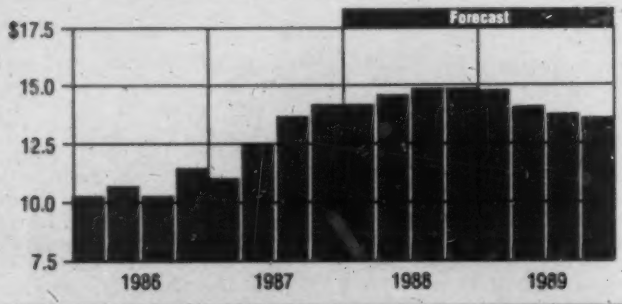
Distributor's share of total semiconductor shipments



Historical data: Semiconductor Industry Association; Forecast: Cahners Economics

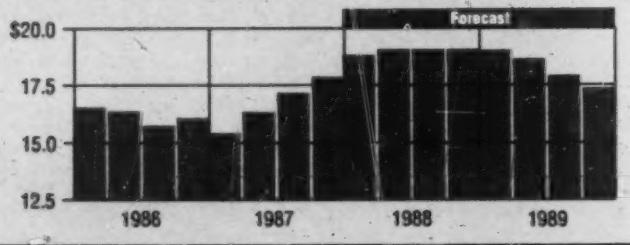
Electronic components — new orders

End-of-quarter totals, seasonally adjusted ($ billions)



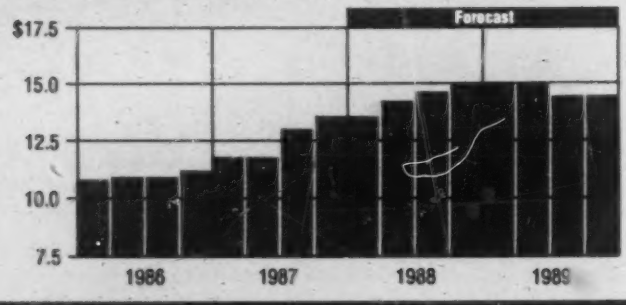
Electronic components — unfilled orders

End-of-quarter totals, seasonally adjusted ($ billions)



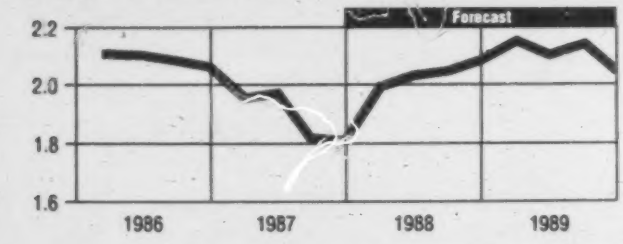
Electronic components — shipments

Quarterly totals, seasonally adjusted ($ billions)



Electronic components — inventory-to-shipment ratio

Quarterly averages, seasonally adjusted



Historical data: U.S. Commerce Department; Forecast: Cahners Economics

Electronic components future looks rosy

Shipments and bookings of electronic components grew over 4% in the fourth quarter of 1987 from the prior quarter, continuing the upward trend of the current recovery. In a retrospective look at 1987's component statistics, two other vital trends reveal good news for the future.

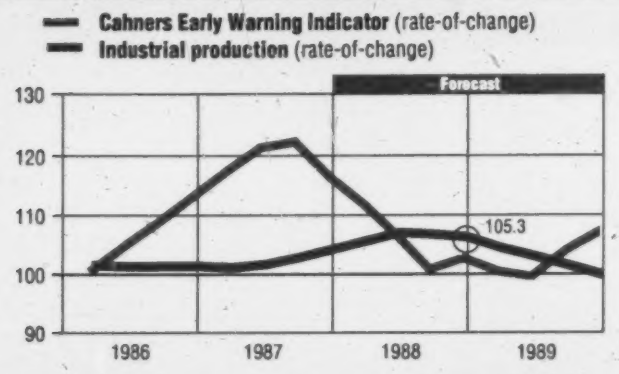
First, bookings remained level with outpaced billings for each of the last nine months of last year (and again in January 1988). This was the best book-to-bill performance since 1984 and bodes well for rising backlogs in 1988. A healthy level of backlogs means U.S. factory production will have a satisfactory buffer for any shipment missteps during the year. Backlogs stood at $17.8 billion in December 1987, the highest level since March 1985, when backlogs hit $18.5 billion.

Second, and more importantly, inventories have remained amazingly low. While inventories have been growing, they have not been surging ahead of shipments. Last year, inventories grew just 3.2% while shipments picked up 14.1%. This inventory control has kept the inventory-to-shipments ratio at its lowest levels ever. This is extraordinary behavior given the fact that the electronic components industry recovery is approaching its two-year anniversary.

In 1985, the inventory-to-shipments ratio for U.S. components makers hit the 2.3 mark. This signaled a serious inventory imbalance. The problem was severe not only at the component factory level, but even more so at the end-user level. As of January 1988, the inventory-to-shipments ratio remained at the 1.8 mark and Cahners Economics does not expect the level to rise above 2.1 over the next year.

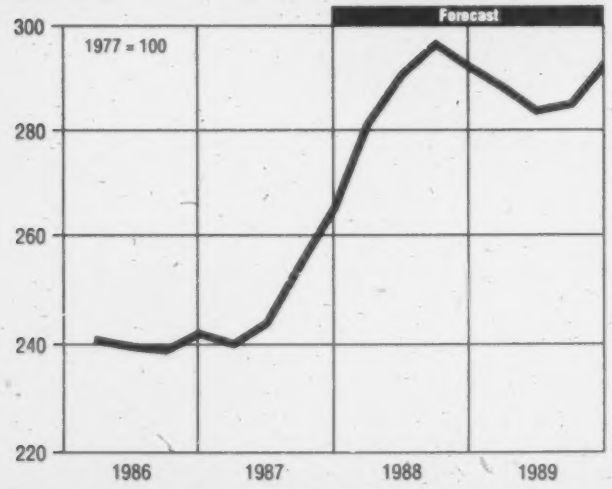
With inventory management now finally taking a front seat in business planning, the electronic components industry will see only a mild downturn ahead in 1989. Cahners Economics predicts orders for components will rise 14.1% in 1988, slowing from the 20.5% growth rate of 1987. Then, in 1989, Cahners expects only a 3.9% drop in orders, far less severe than the 17% free-fall of 1985. In fact, a 3.9% drop in orders may not even result in a decline at all in shipments next year.

Economic indicators



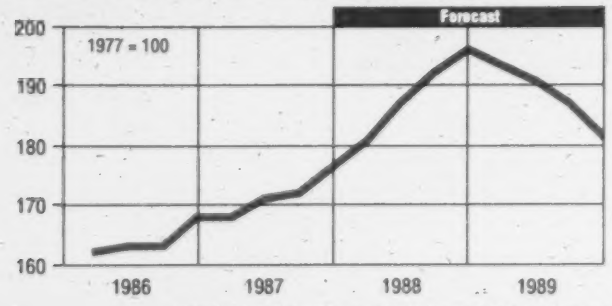
Electronic components — industrial production

Industrial production index, seasonally adjusted quarterly averages



Equipment, instruments and parts — industrial production

Industrial production index, seasonally adjusted quarterly averages



Historical data: Federal Reserve Board; Forecast: Cahners Economics

U.S. production growth remains steady

The indicator peaked in the third quarter of 1987 and is heading for a low point in the second quarter of 1989. But the downturn will be mild and short-lived, according to the CEWI readings. The growth expected in U.S. industrial production has been revised downward slightly for 1988 by Cahners Economics. So, instead of slowly accelerating growth this year, industrial output will hover around the 5.1% to 5.9% range all year, before heading down in 1989. The reason for the revision? Inventories of imported goods are high. This could result in greater import price competition and U.S. manufacturers could feel the heat. Still, export growth and renewed business investment will steer U.S. industry to steady growth gains this year, albeit somewhat lower than Cahners' predictions several months ago.

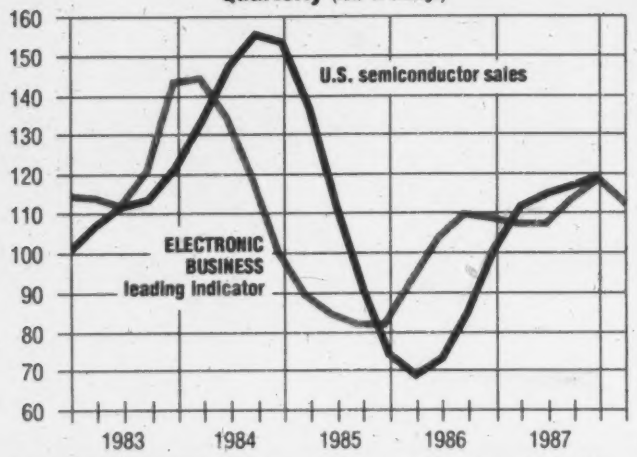
More information can be obtained from Elizabeth Baatz, economist, Cahners Economics Department, 275 Washington St., Newton, Mass. 02158.

Recovery for instrument and component markets

Both the instruments and the components markets continued to shine in the final quarter of 1987 and are expected to have shown similar growth in early 1988. Industrial output of equipment, instruments and parts rose 3.0% in the fourth quarter and is expected to rise another 2.1% in the first quarter of 1988. As for electronic components, the figures for these two quarters stood at 4.1% and 5.9%. The component recovery has been led by a surge in demand for semiconductors. While semiconductor sales in the United States and Canada grew over 20% in 1987, all electronic components output at U.S. factories rose a more modest 5%. In 1988, electronic components output is likely to increase 15.6%. Instruments output is expected to rise 9.8%, after a 4.7% upturn in 1987. With both industries, growing export sales will be a major factor in any optimistic production projections.

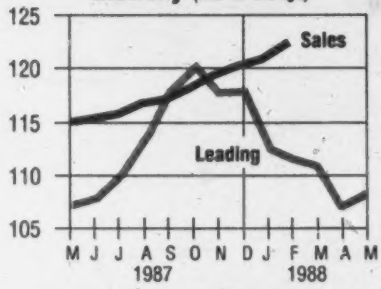
ELECTRONIC BUSINESS leading indicator

Quarterly (rate-of-change)



The ELECTRONIC BUSINESS leading indicator predicts turning points in U.S. semiconductor sales with about a three- to nine-month leadtime. For more information please contact Elizabeth Baatz, senior economist, Cahners Publishing Co., 275 Washington St., Newton, Mass. 02158 or call (617) 558-4368

Monthly (rate-of-change)



The ELECTRONIC BUSINESS leading indicator fell to 112.8 in January from 118.0 in December. The majority of the January-December decline in the indicator was due to a drop in semiconductor stock prices. Estimates for the next two months show the indicator dropping slightly to 111.8 in February and 111.1 in March. The turning point peak in this indicator occurred in October 1987, so semiconductor sales growth is expected to begin dropping off this spring.

Source: Cahners Economics

Electronic industry indicators this month

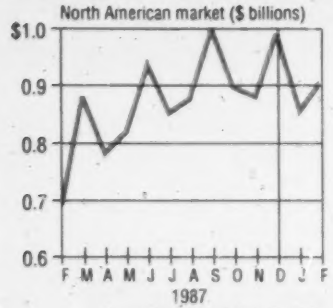
	Latest month	Previous month	Year ago	1987 average
ELECTRONIC BUSINESS leading indicator (rate-of-change, Jan.)	112.8	118.0	107.8	111.8
U.S. semiconductor bookings ($ millions, 3-month average, Feb.)	$1,080	$1,014	$794	$951
Weekly hours of semiconductor production workers (monthly average, Jan.)	40.3	41.3	40.8	40.6
Electronic components leadtime index (1977 = 100, March)	106.8	105.5	72.7	100.7
Standard & Poor's semiconductor price index (1970 =10, monthly average, Feb.)	52.94	53.18	60.94	65.5
Change in electronic components inventories ($ millions, SA, Jan.)	+$51	+$48	-$30	+$46
Contract and orders for plant and equipment ($ billions, SA, Feb.)	$37.7	$38.5	$32.1	$34.4

SA = seasonally adjusted, all other data is not seasonally adjusted

Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Commerce Department, U.S. Bureau of Economic Analysis

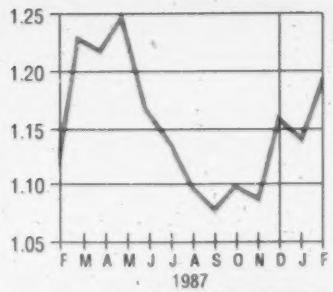
Semiconductor sales

North American market ($ billions)



Source: Semiconductor Industry Association

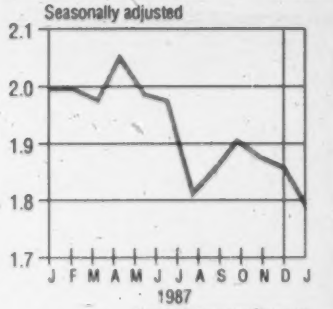
Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments

Seasonally adjusted



Source: U.S. Commerce Department